Technical Memorandum

Potential Considerations of HDPE Pipe

Municipal Applications

for City of Rapid City

Prepared for:
City of Rapid City, South Dakota
Public Works

May 31, 2013

Prepared by:

In association with:
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Abbreviation Key for this Document:

AASHTO: American Association of State Highway and Transportation Officials
ANSI: American National Standards Institute
ASCE: American Society of Civil Engineers
ASTM: American Society for Testing and Materials
AWWA: American Water Works Association
CITY: City of Rapid City, South Dakota
CLSM: Controlled Low-Strength Material
CPE: Corrugated Polyethylene
DENR: South Dakota Department of Environment and Natural Resources
DIOD: Ductile Iron Outside Diameter
DOT: Department of Transportation
DR: Dimension Ratio
EPA: Environmental Protection Agency
HDB: Hydrostatic Design Basis
HDD: Horizontal Directional Drilling
HDPE: High Density Polyethylene
ISO: International Organization for Standardization
LTHS: Long term hydrostatic strength
MJ: Mechanical Joint
NSF: National Sanitation Foundation
PE: High Density Polyethylene
PPI: Plastics Pipe Institute
PVC: Polyvinyl Chloride
RCP: Rapid Crack propagation
TM: Technical Memorandum
UV: Ultra violet
WERF: Water Environment Research Foundation
Technical Memorandum

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May 31, 2013

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The contents of this report reflect the views of the author or authors responsible for the facts and opinions presented in this Technical Memorandum. The contents do not necessarily reflect the official views of the City of Rapid City or its Public Works Department. The survey polling and responses provided herein is intended only to provide an approximation of current HDPE use for a small cross section of municipal and/or water systems throughout the U.S.A. and Canada. This report does not constitute a standard, specification, or regulation.
Executive Summary

The purpose of this technical memorandum (TM) is to provide a recommendation regarding the potential addition of HDPE pipe materials to the City of Rapid City’s municipal utility and drainage system. Data were gathered on municipal utility applications with the sources of information being surveys/contacts with various municipalities (U.S. and Canada), website searches, ASTM and AWWA Standards currently in force. The results of this survey indicate various degrees of acceptance regarding the use of HDPE by municipal utilities. Of the 39 utilities contacted directly, 13 do not allow the use of HDPE and 6 limit its application. Twenty do allow the material in at least one application or more. Of those that do allow its use, several have limited conditions and approvals. Therefore, the first question which must be addressed is whether or not to make a recommendation to add the HDPE material as an alternate. Then, if it is to be permitted, for what applications and under what conditions should it be allowed? The motivation for the City to add an alternate material should be based upon the following:

- Meeting nationally recognized standards.
- Improvement to the longevity of the piping system.
- Improvement in life cycle costs which address operation and maintenance concerns.
- Improved constructability of the system.
- Compatibility with the existing system.

A major concern with the addition of any alternate material is the impact on the current and future operations and maintenance procedures of the utility. With the allowance for an alternate material some operational factors to consider are:

- Time-tested operating history of product systems.
- Training for inspectors and operations staff on proper installation and repair methods.
- Training and appropriate certification for contractors on installation.
- Training for repairs.
- Potential damage from excavating too close to the pipe.
- Maintaining inventory of spare parts.
- Knowing locations of installed material so parts are on hand for repairs or for extensions with dissimilar materials requiring special fittings/adaptors/restraints.
- Parts availability and training for repairs and connections.
- Duplication of parts/materials for dual material systems.

In summary, the HDPE industry has provided extensive outreach and technical information to the emerging municipal utilities market, developed new resin formulations to both improve performance and address previously identified issues, and helped to expand an
evolving product line of electro-fusion fittings, adapters and restraints with methods to connect to other common piping materials and appurtenances. HDPE pipe and tubing materials can offer properties such as flexibility, abrasion resistance, corrosion resistance, and lighter handling weight where needed.

On the other hand, HDPE pipe materials require that special considerations be taken into account at each level – from designer to contractor to maintenance and repair crews. From a technical standpoint, it appears that a properly designed and installed HDPE piping system has the potential to perform as well as other more commonly installed piping products in today’s market. However, it is also for these “developing and evolving” and “potential to perform” reasons the recommendation included within this TM must necessarily be conservative until there is a longer proven “track record”, i.e., more time-tested results before moving into HDPE installations for many of the traditional municipal utilities applications.

Other factors which influenced these TM recommendations included:

- **Lack of apparent widespread municipal utility adoption in the United States** – this situation could result in special fittings and materials being more difficult to obtain or longer delivery times. Banner/Black & Veatch believe it is appropriate to adopt a “wait and see” position at this time as appropriate for several of the applications under consideration to see how the municipal market fully develops. A side issue of not having widespread adoption is a lack of peer support (during design, construction and operation) to both receive and transmit tips and guidance on unique issues that may be associated with HDPE pipe municipal installations.

- **Costs** – a common assumption is that HDPE will be less costly than a comparable PVC piping system for HDD or trenchless applications such as trenchless directional drilling, in-situ lining, or pipe-bursting. However, some of the contacts made with municipalities for this TM survey indicated that for open-cut situations lower costs may not necessarily be the result. Lower material costs may be offset by slower production (e.g., fusion-cooling time, temperature limitations) and special connector and restraint considerations for HDPE. In cities such as Colorado Springs, that allow HDPE pipe for certain water system applications, designers and contractors are often opting to install PVC except in special situations that require the unique properties of HDPE. Market forces can also drive decisions – such as is the case with HDPE service lines currently. The cost savings of HDPE versus copper tubing for service lines may outweigh the risk of not having a long-term proven record for that application. However, no municipal system wants to have widespread implementation of an alternate piping or tubing material that ends up
costing more in the long run due to premature repairs or replacements, such as is the case with the City's historical specification and allowance of the once popular “poly-B” polybutylene tubing materials. This material has now been discontinued.

- **Skill pool is still evolving** – Contacts in the larger metropolitan areas have indicated that the availability of specialty and certified technicians to properly fuse HDPE pipe is still limited. In those municipalities that have chosen to allow HDPE piping for some applications, their local contractors and municipal maintenance crews have had a “learning curve” (more than 10 years in some cases) to become proficient with installation and repair of HDPE pipe. In a community such as Rapid City that is somewhat remote from larger metropolitan areas, the HDPE skill and experience gaps here may also prove to be problematic. As HDPE becomes more “mainstream” and time-tested for municipal use, the skill pool and specialized experience is likely to increase accordingly. At that point, it may be a more beneficial time to expand and transition in a more focused manner to other HDPE uses or applications for Rapid City’s municipal utilities.

**RECOMMENDATION**

Based on the information obtained in the surveys, internet search and discussions with other municipal utilities, this TM recommends that HDPE be added as an alternate material for limited applications at this time. This recognizes the fact that once the pipe material is installed it becomes a permanent part of the system and must be maintained. With the recommendations provided below, it is also recommended that the City’s Infrastructure Design Criteria Manual and Standard City Specifications be revised accordingly.

Recommended applications for the use of HDPE include:

- Water transmission mains with no taps or connections (now or expected in the future).
- Sanitary sewer force mains.
- HDD Trenchless installations; horizontal directional drilling, pipe bursting, and slip lining.
- Roadway edge drains, also known as under drains.
- Water/sewer separation encasements.

Further basis for these recommendations are found in the survey results discussion and comparison sections following this Executive Summary as well as supporting technical and background information provided in the Appendices. This TM is not an exhaustive study of HDPE and its applications.
Purpose of Technical Memorandum

The City of Rapid City is considering introducing HDPE piping as an alternate material in their water, wastewater and storm water systems and requested Banner to do a survey of current use for this material. Banner was requested by the City to evaluate the potential use of HDPE piping materials for its various municipal applications as defined above. Banner teamed with Black & Veatch (which included team members from both Denver and Kansas City offices) to help bring a national perspective and its own technical experience to the overall survey.

This TM should be viewed as a limited scope and effort specifically for the City of Rapid City (hereafter referred to as City), and not a comprehensive or exhaustive evaluation of HDPE for water, sewer and street applications for any other municipal utility. The HDPE industry has invested heavily over recent years developing their product lines, addressing concerns, improving their product offerings, and working with associated manufacturers to develop products such as fittings, adaptors, etc. to incorporate their product into many municipal systems. It is also apparent that thousands of hours have and are being spent by the various standards committees such as AWWA, ASTM, PPI, ISO, etc. to provide updated testing protocol and criteria for the design and use of many HDPE piping systems that are becoming available. As the HDPE industry continues to evolve, it is expected this memorandum’s recommendations will be added to and expanded in the future as a working document for the City, as HDPE use and experience becomes more widely adopted and time-tested for the municipal utility market and corresponding National Standards become more established.

Together with input from the City’s technical staff, Banner’s Team helped develop the following list of potential applications for further consideration:

- Water service lines.
- Water distribution mains.
- Water transmission mains.
- Sanitary sewer service lines.
- Gravity sanitary sewer mains.
- Sanitary sewer force mains.
- Horizontal Directional Drilling (HDD) and pulling of pipelines for special applications (e.g., stream and highway crossings).
In-situ lining to repair existing infrastructure piping (water, sanitary, storm sewer).

In-situ pipe-bursting replacements (sanitary sewer and water).

Storm sewer piping.

Use as casings for carrier pipes.

Water/Sewer separation encasement.

Roadway edge or underdrains (currently allowed by City Specifications).

The purpose of the TM is to provide the City with a recommendation regarding the addition of HDPE as an alternative material based upon the total TM information collected and discussed, including Municipal Utility User Surveys, Internet Search and Standards Development, and follow-up contacts for more detailed information with current users.

## Alternate Pipe Materials – Motivators and Goals

Potential City motivators for changing to an alternative material or system, what are the goals of a typical utility, and what are the City’s service goals are discussed below.

### A. Motivators for Change

Theoretical motivators and reasons for advocating and implementing changes were identified during the TM Workshop Session with the City. Reasons discussed for introducing or allowing alternate HDPE materials and specifications included:

- Material and system improvements with a goal of fewer line breaks and repairs.
- Reduction in corrosion potential considering both pipe materials and appurtenances.
- Reduction in premature leaks and failures at connections.
- Allowance for implementation of alternative construction practices (HDD or trenchless methods for example).
- Influences due to marketing efforts from suppliers/manufacturers.
- Desire to reduce initial capital costs.
- Desire to reduce traffic congestion caused by open cut trench installations.
- Public input/complaints, appeals to reduce business interruptions and allow different installation methods.
- Desire for longer design life before repairs or rehabilitation.
B. Service Goals

For the City to consider allowing an alternate material change, it will be important to first identify the top service goals. As a starting point and based on a national survey of water system operators, a recent August 2012 *Trenchless Technology Magazine* article states the following goals in order of priority for selection of a pipe material:

- Meeting standards.
- Longevity and design life.
- Price and ease of installation.
- Compatibility with existing systems.

By reviewing and comparing the two lists (Motivators for Change versus Service Goals) shown above, it is apparent that there can be competing goals and motivations among the various stakeholders which are not always compatible with each other. The City, as well as most water, sewer, or street utilities, will typically balance and prioritize these service goals and interests in the short term, by reviewing and updating as needed their specifications and design criteria, such as the City is doing by commissioning this TM memorandum. The careful thought and consideration that Rapid City or any city puts into a planning effort such as this will determine the successful performance of the utility system over the long term.

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Data Collection Approach

A. Introduction
   The data collection approach included the following:
   1. Survey questionnaire sent to Black & Veatch offices and municipal clients
   2. Internet survey research performed
   3. Technical design standards and manufacturer information review
   4. Follow up with some Users with more detailed questions; generated contact reports.
   5. The U.S. Map below highlights all the operator locations surveyed, as well as showing locations identified by internet searches.

B. The approach utilized for data collection for this municipal survey of HDPE use was to send a one page survey questionnaire form to the various offices of Black & Veatch around the U.S. (including a few in Canada). Those offices then made contact with their local clients by sending the survey directly to their respective municipal utility operator contacts, and a follow-up by telephone contact was made as needed. Banner also did a search of HDPE municipal applications and case histories using the internet, and provided several more in depth follow-up contact reports where appropriate. This team approach allowed for the collection of data from a broad spectrum in the shortest amount of time, as requested by the City. The telephone respondents identified themselves primarily as operations staff and related their experiences with HDPE pipe applications, which were then recorded on the contact forms. An itemization of the questions asked, and resulting responses and findings of the contacts and searches is found in Appendices A, B and D.

C. In total, municipalities representing more than twenty-five (25) different U.S. states and three (3) Canadian provinces were queried for this TM. See the U.S. map below for both the locations of the municipalities contacted and the internet search hits. A more in depth review of the scanned research material can be performed by using the URL addresses that have been included in the reference section (Appendix D) and as noted in the Material Characteristics and Development section of this TM. South Dakota’s Department of Environment and Natural Resources was also contacted to obtain general observations regarding HDPE use from their water/sewer plans review and approval process for applications proposed for either municipal and/or rural systems in South Dakota. There were also data collected from discussions with attendees at the September 2012 ASCE Pipeline Conference in
Miami and AWWA Distribution System Symposium in St. Louis. This data was also compiled into the results of the survey although the questionnaire was not filled out directly by the interviewee.

D. In addition to providing a summary of the phone and internet survey information collected, currently available AWWA and industry on-line technical design standards, manuals, and manufacturer information were scanned to identify several of the substantive differences between HDPE materials with its own unique installation and maintenance complexities as compared with other available piping materials and installation requirements. Even though a comprehensive technical evaluation was not performed for this TM, it is apparent from the limited internet search survey performed that there is considerable industry and manufacturer design guidance now available for designing and using HDPE piping materials for many applications.
Survey Collection Results

A. INTRODUCTION

An example survey form and all completed survey forms are provided in Appendix A. Disclaimer: This survey is not a ‘Statistical SAMPLING OR SURVEY’.

B. OPERATOR SURVEYS

There were 39 separate municipal utilities that responded to the survey questionnaire sent out which included 25 U.S. states and 3 provinces of Canada. The TM survey polling and responses provided herein are intended only to provide an approximation of a very small cross section of municipal and/or water systems around the USA. The survey asked the operators if they had allowed HDPE and if so for what applications. The most common stated use for HDPE was for HDD trenchless applications. Only one utility surveyed (Colorado Springs, Colorado) indicated that they had used HDPE for direct-bury installation for water distribution piping on a limited basis. A few indicated that they had used it for a direct-bury sewer force main, but none had allowed it for either HDD or direct-bury gravity sewer installations. A few others indicated that HDPE pipe had been used for direct-bury low pressure sewer force mains, without laterals or attachments. The completed TM survey forms and more detailed follow-up contact reports are provided in Appendices A and B.

The results of the survey are summarized in Figure One, and Tables One and Two below. The Survey Form used was approved by the City. A record of how many survey questionnaires were sent out was not kept, but a total of 39 were received, compiled and summarized.

Note: HDD trenchless applications are those that might include horizontal direction drilling, pipe bursting methods, or slip lining.

HDD photo credit: (from www.plasticpipe.org)
Of 39 Municipal Operators responding, only one said they would use the material for open trench installation of water distribution or force main applications. The other 38 Operators stated ‘not used’ for traditional open cut installations for water/sewer distribution applications.

Table One provides additional summary tabular information taken from the detailed municipal survey results representing other applications for HDPE.

**Table One - Results of 39 Operators Responses Continued (not a statistical survey)**

<table>
<thead>
<tr>
<th>Of the 39 municipal operators responding, the number that said:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE allowed in at least one application</td>
<td>26</td>
<td>13</td>
</tr>
<tr>
<td>HDPE allowed for storm pipe</td>
<td>8</td>
<td>31</td>
</tr>
<tr>
<td>HDPE allowed for transmission or force mains</td>
<td>11</td>
<td>28</td>
</tr>
<tr>
<td>HDPE allowed for water or sewer distribution mains</td>
<td>5</td>
<td>34</td>
</tr>
<tr>
<td>HDPE allowed for water service lines</td>
<td>5</td>
<td>34</td>
</tr>
<tr>
<td>HDPE allowed for slip lining, pipe bursting, or HDD trenchless</td>
<td>26</td>
<td>13</td>
</tr>
<tr>
<td>Overall opinion of HDPE:</td>
<td>3</td>
<td>Neutral</td>
</tr>
<tr>
<td>Overall opinion of HDPE:</td>
<td>11</td>
<td>Satisfactory</td>
</tr>
</tbody>
</table>

Of 39 Responses, 97.5% said HDPE not used and 2.5% said HDPE used for Open Trench Installations.
**Clarifying Notes**: For storm pipe or force main use listed above, as derived from the TM survey forms, detailed information regarding capacities, sizes or lengths of pipe used or allowed was not provided. There were not any Operators interviewed who indicated that they had experience with or allowed HDPE pipe for casing pipe.

**C. Internet Search Survey Results**

The results of a limited Internet Search found 46 utilities that had identified HDPE as a potential material for consideration that could be used in some form. Five of those chose not to allow, and 41 allowed at least one application for the material. These TM results were based upon a random search (with primarily positive listings identified as might be expected from a random internet search) for municipal use of HDPE so this information should not be considered a statistical sampling of its use for all utilities across the U.S. There is also some probability that the allowances and uses indicated, other than for storm pipe use, were primarily for HDD trenchless applications. This appears to correspond with the Trenchless Technology Magazine survey results noted in the next section. The Internet Search results are summarized in Table Two as another simplified indicator.

**Table Two - INTERNET SEARCH RESULTS (from 46 hits)—(not a ‘statistical survey’)**

<table>
<thead>
<tr>
<th>Application</th>
<th>Number of municipal website hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive for water main use</td>
<td>3</td>
</tr>
<tr>
<td>Positive for sewer main use</td>
<td>4</td>
</tr>
<tr>
<td>Positive for water service line use</td>
<td>9</td>
</tr>
<tr>
<td>Positive for storm pipe use</td>
<td>25</td>
</tr>
<tr>
<td>Do not allow HDPE pipe</td>
<td>5</td>
</tr>
</tbody>
</table>

**Clarifying Notes/Comments**: The internet search found no internet listings related to the allowance of HDPE pipe for casing pipe. The sewer main and water main internet hits indicated are primarily for pipe bursting, slip lining (trenchless rehabilitation techniques), or force mains where no tapping is being performed. The storm pipe internet listings found were consistent with other trends found in the conditional or limited allowances indicated in several State DOT’s Guidance Documents and Studies regarding use of thermoplastic materials only in controlled situations. These references are cited later in this TM.
D. Trenchless Technology Survey Results

To supplement the findings to the water operator survey and internet search information summarized above, the U.S. trenchless technology industry recently released the results of its own water main survey of U.S. water system operators and consulting engineers (Trenchless Technology Magazine, August 2012). The number of those queried was not identified in their article, only the percentages. Their survey questionnaire represents itself as indicative of a broad cross section of water managers and engineers all over the country with the focus primarily being upon water main rehabilitation and replacement (using trenchless methods). For this reason, it was decided to include a synopsis of some of the selective results that may correlate with the findings of the work done for this TM.

In conducting their acknowledged “unscientific” poll, the managing editor concedes that: “One thing our poll shows is that although trenchless technology is part of the equation when it comes to addressing water main issues, it still has some significant inroads to make to gain municipal acceptance.” A main focus of their survey responses appears to reveal that corrosion is a leading cause of water main leaks and breaks around the country. When asked about the critical attribute for selection of pipe materials and systems, the second leading concern among respondents was longevity of the piping system, with an average value of 64 years stated for required design life. The primary concern stated (for 80% of respondents) was meeting standards.

When asked what type of pipe is the easiest to maintain and/or rehabilitate, and what types of pipe are used for HDD trenchless projects, the results are indicated below.

<table>
<thead>
<tr>
<th>Clarifying questions asked</th>
<th>PVC</th>
<th>Ductile Iron</th>
<th>HDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easiest to maintain and/or rehabilitation?</td>
<td>52%</td>
<td>49%</td>
<td>13%</td>
</tr>
<tr>
<td>Best for HDD trenchless methods?</td>
<td>42%</td>
<td>23%</td>
<td>66%</td>
</tr>
</tbody>
</table>


E. Apparent Trends in HDPE Use

There has been widespread experience gained in the general U.S. pipeline and conduit market especially over the last 10-15 years with its newer emphasis for HDD trenchless technology installations, including internet and telecommunications.
Numerous articles in construction and trade magazines have been written promoting and suggesting the use of HDPE conduit and piping with the latest trenchless and directional drilling methods due to the material’s superior handling and durability characteristics. HDPE pipe and HDD trenchless technology equipment manufacturers have been working hand in hand, and as a result have seen continuing growth due to this widespread use and acceptance of both the material and methods in the gas, telecommunications and electrical utilities markets.

In addition, the history is well established for HDPE’s more traditional areas of use such as mining, petrochemical, gas and irrigation applications for more than 25 years, which continues to this time.

Photo of HDPE Trenchless Directional Drilling HDD Installation  
(from www.allenwatson.com)

Except for the uses noted above, much of the use for HDPE piping since 2000 has been for HDD drilling and subsequent pulling of pipe or conduit beneath highways or rivers for both public and private utilities, much of it in or near metropolitan areas. More recently, within the last 5 to 10 years, the specification and use of both the HDPE pipe material and HDD method has increased within the larger cities where HDD trenchless technologies are used to minimize the footprint of disturbed areas in streets and right-of-ways in front of houses and businesses as compared to traditional open trench pipe installation methods. This also reflects what has been
the primary HDPE use to date within municipal or rural water systems in South Dakota. SD DENR indicated that other than smaller service lines, HDPE experience and use has been essentially limited to HDD trenchless installations (not precluded by regulations). Nationally the demand for less disruptive means and methods to install utilities beneath streets, highways, and already developed areas has put market pressure on the suppliers/distributors of HDD trenchless technology to provide better materials and methods for precision control of the pilot bores which guide the final pipe placement in the ground. Specialty HDD equipment manufacturers have risen to this challenge to meet the demand of the specialty utility markets, and therefore the HDD delivery technology and methodology has improved dramatically over recent years.

The polyethylene industry has also pressed forward with recent advances in resins technology, now recently available, which appears to be a response to the earlier problems documented and associated with RCP (rapid crack propagation) failures in HDPE pressure piping applications during the 1970’s and 1980’s. There is a brief reference in AWWA PE Pipe --- Design and Installation, Manual of Water Supply Practice M55 (2006) entitled “Recent Advances” which alludes to these newer resin developments. The Manual of Practice Page 3 states that many of these advances are now “…recognized as offering higher levels of technical performance under ISO standards for HDPE piping that are common outside of North America. These higher levels of technical performance are not yet recognized within the North American standards system.”

F. Case Study Observations

The results of this TM survey, combined with a review of the industry’s PPI website, and specific manufacturers, indicate that HDPE pipe material’s acceptance is still limited primarily to specialty HDD type projects and applications for the vast majority of municipalities across North America, with just a few exceptions. It is noteworthy that a number of municipalities already allow its use for HDD directional drilling or trenchless applications where tapping of the pipeline is generally not needed.

For those systems using HDPE pipe in the trenchless directional drilling category (as differentiated from open trench or direct burial installations), the most common applications are either for stream, wetlands, and highway crossings. Another common use of HDPE piping materials is for pipe bursting and/or slip lining
rehabilitation installations of existing damaged or failing piping (drainage and sewer) systems. This is a recent development also for the Denver municipal and water authority that was contacted for this TM with recent changes incorporated to allow HDPE in their December 2012 standard specifications.

Upon reviewing the case histories provided by the HDPE pipe industry’s websites (summarized below), it can be confirmed that widespread acceptance of HDPE materials for traditional municipal water and sewer distribution systems has not yet occurred in the U.S. In general, most of the survey respondents interviewed for this TM do not allow HDPE materials for their open trench water and sewer distribution systems. This appears to be due to both technical and economic reasons.

The industry case studies found during this study as provided by the Plastic Pipe Institute (2012) are shown in Table Three. The HDPE industry has also conveniently included a link for many of the commonly asked questions regarding use of the material.

<table>
<thead>
<tr>
<th>Application</th>
<th>URL</th>
<th>Case Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trenchless (HDD and pipe bursting)</td>
<td><a href="http://plasticpipe.org/municipal_pipe/trenchless_applications.html">http://plasticpipe.org/municipal_pipe/trenchless_applications.html</a></td>
<td>37 listed</td>
</tr>
<tr>
<td>Sewer force main</td>
<td><a href="http://plasticpipe.org/municipal_pipe/sewer_success_stories.html">http://plasticpipe.org/municipal_pipe/sewer_success_stories.html</a></td>
<td>5 listed</td>
</tr>
<tr>
<td>Mining, gas, industrial and geothermal applications</td>
<td><a href="http://plasticpipe.org/municipal_pipe/industrial.html">http://plasticpipe.org/municipal_pipe/industrial.html</a></td>
<td>Dozens listed</td>
</tr>
<tr>
<td>Municipal water distribution (open trench)</td>
<td><a href="http://plasticpipe.org/municipal_pipe/water_success_stories.html">http://plasticpipe.org/municipal_pipe/water_success_stories.html</a></td>
<td>2 listed</td>
</tr>
<tr>
<td>South Dakota pressure pipe (river crossings and intakes only)</td>
<td><a href="http://plasticpipe.org/pdf/PE_pipe_supplies_south_dakota.pdf">http://plasticpipe.org/pdf/PE_pipe_supplies_south_dakota.pdf</a></td>
<td>1 listed</td>
</tr>
<tr>
<td>Sewer distribution (open trench)</td>
<td><a href="http://plasticpipe.org/municipal_pipe/sewer_success_stories.html">http://plasticpipe.org/municipal_pipe/sewer_success_stories.html</a></td>
<td>None listed</td>
</tr>
<tr>
<td>Water service lines</td>
<td>None listed</td>
<td>None listed</td>
</tr>
</tbody>
</table>
Technical Standards Review

A. RELEVANT STANDARDS

1. After reviewing the most recent HDPE standards and industry information, manufacturer data, and general properties of the material, the potential impacts on critical municipal maintenance and operations were also considered, as later discussed in this TM, before arriving at the recommendations found herein. The following is an abbreviated listing of a few technical standards and design manuals that are available for some of the applications envisioned for future use of HDPE pipe products and materials. Standards have been developed for most of the various types of configurations available; including smooth wall, corrugated, profile wall, perforated tubing and piping.

<table>
<thead>
<tr>
<th>Standard or Manual</th>
<th>Title</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWWA C-906</td>
<td>Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 63 In., for Water Distribution and Transmission</td>
<td>Notice given May 2012 for upcoming AWWA C-906-12 (currently unpublished- still under review) See Appendix F</td>
</tr>
<tr>
<td>AWWA M-23</td>
<td>PVC Pipe – Design and Installation (2nd Edition) Water Supply Practices Series</td>
<td>This includes comparison data for linear expansion coefficients (p.40) for different pipe materials, including PVC and Ductile Iron</td>
</tr>
<tr>
<td>ASTM M 252-09</td>
<td>Standard Specification for Corrugated Polyethylene Pipe</td>
<td>For non-pressure applications, such as sewer or storm pipe</td>
</tr>
</tbody>
</table>
B. COMPARISON WITH PVC AND OTHER PIPING MATERIALS

Several HDPE pressure pipe design and material properties have been compared to other materials currently allowed by City Standard Specifications. An abbreviated comparison of HDPE with ductile iron and PVC materials has been provided utilizing several ASTM test and related design criteria. See Table C-1 found in Appendix C. Table C-2 in Appendix C provides a comparison of HDPE with fusible PVC dimensions and properties for further reference. Note: See also Appendix E for a related, more detailed HDPE pressure class selection chart based on the current AWWA C906-07 standard.

An interesting contrast for the two material standards histories, for PVC and HDPE pipe diameters larger than 4 inches, is shown here side by side for water distribution service:

<table>
<thead>
<tr>
<th>Milestones in Water Pipe History for:</th>
<th>PVC</th>
<th>HDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Water distribution pipes laid in the U.S.</td>
<td>1955</td>
<td>1988</td>
</tr>
<tr>
<td>Initial Standard for ASTM Pressure-Rated Pipe</td>
<td>1964</td>
<td>1989</td>
</tr>
<tr>
<td>First AWWA Standard for Pressure Pipe</td>
<td>1975</td>
<td>1990</td>
</tr>
<tr>
<td>Latest AWWA Standard Issue Date</td>
<td>2010</td>
<td>2007</td>
</tr>
</tbody>
</table>

HDPE was introduced approximately 25-30 years after the introduction of PVC for municipal piping use as can be seen from this table. The performance history for PVC is therefore more established, and significantly more widespread having achieved a 78% share (from an earlier survey) of the water distribution pipe market by 2004.

The development of HDPE resin materials has continued at a rapid pace since 2000, as the revision summary for the applicable ASTM D 3350 Standard below shows.
The eleven ASTM D3350 specification revisions over the past twelve years shown here provides further evidence of the apparent evolving nature of the newer resins and products into the various pipeline markets. This will impact the starting dates for future field performance evaluations, and knowledge derived from experience, for these corresponding installations.

Generally speaking, relative to other materials, HDPE pipe materials are relatively new to the overall municipal market. Further, there currently exist only laboratory tests for predicting its service life under pressure. There is no HDPE pipe in municipal pressure or gravity service for more than 20 years that is available for study. Since HDPE has a more recent municipal history, it appears to be more suited for limited, lower risk, or other qualifying use applications based on the years it has been in service. As discussed later in this TM, many of the general material properties and performance features for the various types and configurations of HDPE pipe may either be favorable or unfavorable depending on the specific application under consideration, when compared with other materials that are available.

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Material Characteristics and Development

A. General Characteristics of HDPE pipe for Drinking Water Systems

1. To meet current ANSI/AWWA C906-07 Standards, HDPE pressure pipe should conform minimally to PE code designation PE 3408. See Appendix E for more details. This standard specifically addresses working pressures up to 254 psi (DR 7.3) for this PE code designation. An updated release of the AWWA C906 Standard is anticipated in the near future (See Appendix F – ASTM May 2012 Standards Notice, but no official release date has yet been identified). The new standard when it is released will likely include the newer PE 4710 resin and may become the new industry standard PE resin for pressure pipe applications. HDPE pipe is manufactured from a premium high density polyethylene resin compound and is a lightweight, durable and flexible material.

2. HDPE pressure pipe has only been manufactured for water service since 1988; therefore, there is limited historical data to estimate its life expectancy. However, testing is underway to prove that it has a theoretical life expectancy of at least 100 years. HDPE pipe does not require lining or coating and is not susceptible to corrosion. However it is temperature-sensitive and is generally designed for a maximum temperature of 73° F. If used at higher temperatures, its pressure rating must be de-rated.

3. Due to its material properties, HDPE pipe products will have a thicker wall section for the same pressure application when compared to other typically used products, such as ductile iron or PVC. For example, a nominal 24-inch diameter HDPE pipe (DR 11 – DIOD (Ductile Iron Pipe Size)) rated for 160 psi has a wall thickness of more than 2.3 inches, and has an inside diameter (I.D.) of approximately 21 inches. HDPE manufacturers claim that the difference in hydraulic capacity due to the nominal pipe size being based upon outside diameter and providing a smaller inside diameter can be made up with the higher coefficient of friction of approximately 140 (Hazen Williams “C” factor) for HDPE pipe than the “C” factor of 120 or lower for other materials. Notwithstanding this HDPE industry claim, standard design practice is not to use a higher “C” factor than would be used for PVC pipe. For the example of a 24-inch pipe, typically an HDPE pipe with an inside diameter that is at least that of the PVC pipe would be provided, or in this case a 30-inch nominal DIOD. (30-inch PE, DR 11 pipe has an average inside diameter of 25.83-inches). See Figures 1-A and 1-B in the Pipe Material Comparison Appendix C for other size and
pressure class comparisons with PVC Pipe. DIOD under the current AWWA C906-07 (PE3408) for commonly available Dimension Ratios (DR) are:

- DIOD DR 9 (200 psi)
- DIOD DR 11 (160 psi)
- DIOD DR 13.5 (128 psi)
- DIOD DR 21 (80 psi)

Under the current ASTM F714-12a (Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter), available DR and associated pressure ratings are:

- DIOD DR 9 (250 psi)
- DIOD DR 11 (200 psi)
- DIOD DR 13.5 (160 psi)
- DIOD DR 17 (125 psi)
- DIOD DR 21 (100 psi)

4. An example follows of a municipality taking into account the inside diameter differences of HDPE for their general conditions/specifications:

“Due to the pipe wall thickness of HDPE pipe, it may be necessary to upsize the HDPE pipe to have an equivalent I.D. of the type of pipe material shown on the plans. Such increase of HDPE pipe sizing shall be considered subsidiary to providing equivalent pipe and not be bid or paid for separately.” Source: Wichita, Kansas 2012 Water Specifications

5. The number and type of joints directly affects the construction of a pipeline. The standard length for a section of HDPE pressure pipe is 50 feet. HDPE pipe can be joined by thermal butt fusion, electro fusion, flanged assemblies, or mechanical methods. The electro fusion and thermal butt fusion joints are typically stronger than flanged or mechanical joints. Special considerations for joints used with HDPE pressure pipe subject to high working pressures are discussed in more detail in following sections.

6. It is essential that the pipe should not be stored exposed to the sunlight for more than a few months, and the addition of UV protection additives should be considered in the specification to prevent deterioration of the pipe. HDPE pipe is also now available, with a necessary UV protection component, in the suitable color or with a stripe to indicate its use (application).
7. General HDPE Material Properties-
   a) Introduction

There are numerous differences between HDPE piping materials and other piping materials with which designers have more familiarity. The attributes of HDPE materials are good for some City applications, but might prove problematic for others. The tendency of the material to float, for example, makes it a good application where buoyancy is desired for trenchless applications, during launch and pull back of pipe operations performed in waterways, but may require extra bracing and precautions to avoid uplift during traditional open cut type installations (See corresponding buoyancy data in Pipe Material Comparisons - Appendix C). Note that a comprehensive comparison of HDPE to address all of the attributes and differences with other materials is beyond the scope of this TM.

The example noted above is true for many of the application possibilities – where some HDPE material attributes might work well, others not as well, so a Specifier/Engineer must be cautious to carefully weigh the different factors on a case by case, and often times project specific, basis. It must be kept in mind that HDPE pipe and its components are not just simply a different, or ‘Or Equal’ material that is being selected or specified, it is an entire ‘system’ that is being chosen. Once the material selection has been made, with it comes a myriad of options and choices that should be carefully considered and specified for each type of application in order for the entire installation to have a successful outcome.

Armed with a better understanding of the properties of the HDPE material system as is only briefly summarized for this TM, City consultants or engineers may come to an informed conclusion regarding the suitability of the material for a particular application. Many of the design considerations that are summarized on pages 15-25 below are redactions taken from the corresponding pages (pp. 3 -- 126) of AWWA’s Manual Of Practice M 55, PE Pipe --- Design and Installation (1st Edition). It would be advisable to consult this and other available technical resources for more in depth information about HDPE pipe materials to be utilized for pressure applications.
b) **Thermal Expansion.** HDPE pipe is affected more by temperature changes than either PVC or ductile iron pipe. Designers need to account for thermal expansion and contraction when using HDPE pipe. “Like most materials, polyethylene is affected by temperature change. However, polyethylene’s response to temperature change is significant and unique when compared to other ‘traditional’ piping materials. Polyethylene pipe design for thermal change may be significantly different compared to other piping materials.”\(^1\) HDPE has four times the expansion coefficient of PVC, for example. It should be noted that a change in the pipe diameter or wall thickness will not affect its expansion coefficient.

c) **LTHS (long-term hydrostatic strength) Properties and Resistance to Slow Crack Growth.** The pressure capability of HDPE pipe is defined by ASTM D2837 which is the standard extrapolation method used and accepted in North America. A stress-rupture protocol is thereby established for the evaluation of differing pipe resins and results are compared and summarized in terms of a stress intercept called the, or LTHS. For HDPE this strength is more susceptible to temperature variations than many other piping materials. In addition, much research has gone into understanding the formation of microscopic fractures in the material, which can lead to larger flaws or fracturing when under constant hydrostatic pressure over time. Newer higher performance HDPE pipe materials such as the PE 4710 resin materials during recent testing exhibit no downturn prior to the extrapolated 50-year intercept point. If a pipe manufacturer complies with the proposed AWWA C906 (not yet adopted as of this TM writing) standards requirements, this may indicate the material will perform at the required levels of resistance to prevent slow crack growth. There are currently discussions among the standards development committees to revise the current AWWA standard to allow the use of the newer PE resin materials, but this has not yet occurred. The newer resins also appear to better resist oxidative (chlorine) effects through the use of additives for better slow crack growth resistance. While the newer PE4710 pipe resin appears to show much improved slow crack growth resistance over previous resin types, the improvement in HDPE pipe additive packages has also had a significant

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affect. While it appears that the earlier HDPE resin formulations performed well in many applications, there were some isolated cases where HDPE pipes under pressure lasted less than the required 50 years per the current standards formulations requirements.

d) Poisson Effects. Creep and Stress relaxation - Because of its viscoelastic nature, the response of HDPE piping systems to loading is time-dependent. When an HDPE pipe is subjected to a constant static load, the material continues to deform indefinitely at an ever decreasing rate. The material may yield or rupture if the load is high enough. This time-dependent viscous flow component of deformation is called creep. When subjected to a constant strain (deformation of a specific degree) that is maintained over time, the load or stress generated by the deformation slowly decreases over time. This is called stress relaxation. These two Poisson effects have the potential of generating extremely large pull out forces at fittings and joints.

Once it was thought that ‘snaking’ the pipe in the trench would help to overcome the negative effects caused by these properties, and prevent failures from occurring. This is now known to not be effective, and has been removed from most industry guidance documents. Instead, to prevent Poisson effect pullout disjoining, protection should be provided for the pipeline by installing external joint restraints at unrestrained bell and spigot joints, or by installing an in-line anchor in the HDPE pipeline, or by a combination of both techniques.

The HDPE pullout force must be calculated prior to installation, to make sure that the appropriate anchors (typically called pipe collars or wall anchors) are sized and placed as necessary. Pipeline shortening will occur whenever the pipe is pressure tested, and if not addressed will likely result in failures at connections or in-line fittings, including connections with other pipe materials.

e) Viscoelastic Properties. Given some of the above effects and issues, it would seem that there are many negative effects that must be counter-acted for a successful installation. Although this is often the case, on the other hand, some of these same properties give HDPE pipe material some strong advantages when compared to other materials. Because the pipe tends to want to move, it is the case that it is well suited for areas of soil instability
which are prone to move, or slide, or displace over time. In fact, it has been documented that this material has performed well in many of these cases and may be the best application of its use compared to alternative materials which are not as flexible.

f) **Ability to Handle Surge Pressure Events.** Similar to the case above, the same time-dependent responses to loading is also what gives HDPE its unique resiliency and resistance to sudden, short-term loading phenomena - such as would happen during a surge pressure event inside the pipe. The material performs very well in this case, and helps to absorb or attenuate some of the wave energy, that is otherwise reflected and accentuated off of the walls of more rigid wall pipes. This is true of both PVC and HDPE materials which results in lower surge pressures than the higher modulus materials such as for ductile iron or steel pipe.

g) **Corrosion Resistance.** The polymer and resin used in HDPE pipe is electrically nonconductive and therefore not subject to galvanic action in naturally occurring soil conditions. Therefore, it makes this pipe material an excellent choice if this property is needed to counter act the effects of highly corrosive soil conditions.

h) **Impact Resistance Properties.** The amount of energy that a material can absorb without breaking or fracturing is known as the impact strength. ASTM D 256 allows use of either the Izod Impact or Charpy Impact Tests to determine this for HDPE. The results indicate that using the Izod test, HDPE is approximately 8-10 times more resistant to damage than PVC pipe material. However, HDPE pipe has approximately 50% of the impact strength of ductile iron pipe for comparison.

i) **Hydrocarbon Permeation Potential.** Tests indicate that HDPE is somewhat less resistant to hydrocarbon permeation than other materials. However, PVC and other elastomer joining materials and gaskets are also subject to permeation. ANSI/AWWA C906, Sec. 4.1 should be consulted for additional information and consideration, prior to making final selection and specifications, where hydrocarbons may be present.
j) **Health Effects.** NSF/ANSI Standard 61 Drinking Water System Components-Health Effects is a consensus standard promulgated by NSF International. NSF/ANSI Standard 14- Plastics Piping System Components and Related Materials establishes minimum physical, performance, and health effects requirements for plastic piping system components and related materials. These criteria were established for the protection of public health and the environment. According to the PPI (Plastics Pipe Industry) website, HDPE pipe can meet the required NSF 61 and NSF 14-2012 requirements.

k) **Deflection Capabilities/Limits.** Pipe deflections, if not considered beforehand, may result in installations that do not meet minimum deflection criteria (typical range of 2 to 3 %) needed for any significant roadbed construction built over the pipe. Given the susceptibility of smooth wall pipe to oval out over time if not under constant pressure, smooth wall pipe must be carefully bedded and backfilled to resist this tendency.

l) **Joint Types**
   
   i. **Thermal Butt Fusion.** Thermal butt fusion is the most commonly used method of joining HDPE pipe. It is done using portable equipment which secure pipe or fittings in close alignment while opposing butt-ends are faced, cleaned, melted and fused together, and then cooled. Properly fused joints will be fully restrained and should not leak.

   Butt fusion involves:

   1. Securely fastening the components to be joined.
   2. Facing the component ends being joined (to provide a flush and clean surface).
   3. Aligning the component ends.
   4. Melting the component ends (at the required temperature, and duration).
   5. Applying force to fuse and join the component ends together.
   6. Maintaining the applied force until the joint has cooled for the specified amount of time.
   7. The use of a data logging device is strongly encouraged to monitor and record all of the critical variables which must be controlled during this process.
Example of butt fusion welding (courtesy of www.performancepipe.com)

Typically, for smaller installations the pipe is moved to the welding machine for butt welding. Typical welding strings are 500 to 1500 feet or longer. This works well for trenchless application, but the opening up of this much open trench prior to backfill may prove problematic for many municipal settings. There is more than 20 years of general industry experience using this type of weld and procedure, so the technology is well developed for the pipe material and use of this method. Ambient temperatures during installation will impact the rate and ability to perform this controlled weld process. Specifications usually provide a low temperature limit below which fusing is not allowed. Higher ambient temperatures will increase cooling time before the joining force can be released. Both of these factors can negatively affect installation production. Tenting of the joining machine (with butt fusion) may be required to protect the integrity of the fusion joint from rain or other wind-blown contaminants. Stringent quality controls are recommended, and
welders should always have certification papers available to show their competency level.

Fusion of dis-similar HDPE resins - There are different types of resins now available and care must be exercised in joining these together.

Different Fitting and Pipe DR ratios - For pressure pipe, only fittings with the same or greater DR ratios should be butt fused together.


iii. **Electro-fusion.** Electrofusion is a newer technology which is accomplished by application of electrical energy to a wire coil or other conductive material that is an integral part of the HDPE fitting. Electrofusion fittings are clamped or anchored to the pipe temporarily as shown in the illustration below before heat energy is applied. The intent is to melt both the host pipe and fitting surfaces sufficiently to force the melted surfaces together, which if done properly at the right temperature and duration, will become a new monolithic whole. The use of this procedure has had mixed results (with some of it due to improper application procedures) over the last 10 years, and the user responses reflect this reluctance to accept at this time. Newer types of fittings and better procedures appear to be coming available, and the picture will undoubtedly change for this method with more time and experience. Corporation stop saddles are one variety of the newer type of fittings where more case history experience is needed.
iv. **Flanged Joints.** For HDPE flanged joining, a flanged assembly consisting of a metal backup flange or ring and a polyethylene stub-end or flange adapter is used. The backup flange is placed over the pipe profile, and the stub-end or flange adapter is then fused into the plain end pipe. Flanged joining methods may be used to make connections to polyethylene pipe, alternative piping materials, and to pumps, valves, and other appurtenances. However, the use of flanged joints is generally not recommended for buried installations.

v. **Other.** Other joining methods for HDPE pipe include socket fusion, compression-type connectors, wrap-around clamps, saddle fusion, and various quick-connect devices.

Because all the above joining methods have certain performance limitations, they should be used selectively after consultation with the pipe manufacturer. Special installation techniques, such as anchoring of the pipe and backfilling and compaction methods will be required in areas of high groundwater. Regardless of the jointing method, they should only be performed by properly trained and certified personnel. An example of a re-rounding wrap-around clamp, sometimes needed before fusion welding takes place, is shown below.
m) Appurtenances

i. **Mainline Fittings and Fabrications.** There are now available specialty HDPE bends and fittings, which may be butt fusion welded to the pipe in the field, where needed for offsets and changes in direction or slope. Fittings such as tees or elbows are fabricated from HDPE at the factory and are joined by field or factory welding to the ends of pipe as described above. In practice, however, few of the users interviewed for this TM survey actually had much experience with these HDPE fittings. In a few cases the experience was less than satisfactory. The reason for this is typically fitting welds must be accomplished down in the trench, as attempting to move and lower a fabricated fitting that is connected to multiple pipe sections frequently damages the fitting. For this reason, if the pipe requires cutting in the field to make connections, the work must be done carefully and in accordance with the manufacturer’s recommendation.

Based on the municipalities surveyed, these types of fittings should be used sparingly and only if other options are not feasible. Connections to other pipe materials require a flange, adapter, or
special fittings. Note: Fabricated fittings if specified, should match the pipe pressure class itself, and also comply with ANSI/AWWA C906 and ASTM F2206 to provide full pressure rating.

Appurtenances such as outlets for blow-offs and air relief valves in low pressure locations can be field tapped and fused together. If high pressures necessitate special connections, the pipe openings for the appurtenances may need to be reinforced with collars or sleeves during fabrication. Specific pressure limitations for fittings and collars should be determined during design.

ii. **Branching and Tapping Using Fusion Methods.** The available HDPE manufacturer literature provides guidance on how to accomplish branching and tapping for pressurized municipal services. In practice, however, few of the users surveyed actually have much experience with this. The few that had experience indicated that it was less than satisfactory. For this reason joints using fusion joining methods must be approached carefully and thoughtfully, if at all.

iii. **Service Connections Using Fusion Methods.** This HDPE method solicits very similar comments from survey respondents as those for branching and tapping noted above. This is a very specialized endeavor, and should not be attempted without a very thorough and clear understanding of the process, training, tools, and potential risks associated by going with this method.

iv. **Special Mechanical Fittings, Saddles, Sleeves, Stiffeners and Attachments.** Mechanical joining is also another way for joining different HDPE segments to other fittings or pipeline appurtenances, or to dis-similar materials such as PVC, ductile iron, or steel pipe. All mechanical joint products used with ANSI/AWWA C906 and C901 pressure piping systems must provide restraint against pullout for pressure applications. Seal-only joining devices are not suitable for joining HDPE pressure piping. Many of the fittings are now being produced in practically all the sizes of HDPE pipe available. Both cathodic and corrosion protection for metallic fittings should also be considered.

Transition fittings such as HDPE MJ Adapters are now available which can be pre-assembled at the manufacturer’s facility. MJ Adapters
can be supplied with a stub HDPE pipe piece option that has a fused collar. When installed this collar will be located between the MJ fitting and the gland (gasket in front of collar – and longer bolts must typically be ordered). These fittings are normally pull-out resistant, seal tight with pressure and have tensile values greater than that of the HDPE pipe portion of the system. However, the user should insist on information from the manufacturer to confirm design capabilities or limitations. It is also possible to obtain hydrants and valves with HDPE ends pre-installed at the factory so that they can be butt fused into the pipeline string more quickly in the field.

Careful alignment between pipe and fitting is always critical, because HDPE pipe stresses are such that it can break brittle metallic flanges. Extra strength or heavy duty flanges are often specified due to this concern. Bolt torqueing recommendations are many times ignored, and will make the difference for future leaks. Internal stiffeners are advised by AWWA at all mechanical joint connections because of the materials tendency to ‘relax’ and lose mandatory fastener compression and connection integrity otherwise. The stiffeners are typically made from stainless steel to mitigate the corrosion potential.

Some products, such as fire hydrants, can be ordered with HDPE stubs installed at the factory. Extra length stub ends from the factory for MJ type fittings will almost always assist in alignment, field installation, and overall quality of workmanship during fit ups and placement.

HDPE pipeline thrust forces, however, must be adequately designed for and controlled so that the above connections remain serviceable. Provisions for wall collars and other devices and methods are advised so that the pipeline itself does not induce stresses into the ductile iron fittings and appurtenances at a stress level greater than that for which they have been designed.

n) Pipe Design – Loading Criteria
The loading criteria for HDPE pipeline design, considering internal and external loading, is as would be expected for any flexible pipe material to be evaluated. The internal pressure will be determined based on the final
design and head requirements of the system. The possible operating conditions that would likely have an effect on the internal pressure requirements would include a look at both pumping cycles and surge pressures.

The external loads include the weight of backfill, soil overburden and groundwater pressures, and live loads from construction and traffic. The presence of groundwater or potential for flooding also creates criteria to be evaluated for floating of the pipe. Floatation can be prevented in many instances by densifying the subgrade and providing sufficient cover. An adequate depth of suitable backfill may temporarily serve as an adequate anchoring force. If the depth of bury is insufficient additional weight can be provided using concrete weights or other methods.

o) **Trench Section**

The trench section required for installation of HDPE pipe can impact the cost and installation of the material selected. The minimum depth of bedding material varies for each pipe material, expected unevenness of the trench bottom, and the bedding angle. The bedding material is also a factor and may consist of aggregate base, sand, crushed rock, or controlled low strength material.

The bedding around the HDPE pipe will also vary based on the material selected. The compaction of the bedding material to fill the voids under the haunches of the pipe can be difficult and must be a consideration in the overall capital cost evaluation.

The trench backfill material should be material that is either select backfill or granular backfill. The availability of backfill material may impact the cost of installation.

p) **Trench Width**

Trenches for rigid pipe should be kept narrow in order to minimize the loading imposed by the weight of the backfill. The trench width for flexible pipe must always be wide enough between the trench wall and the pipe to allow for proper placement and compaction of the bedding and backfill material. This is true for both PVC and HDPE pipe materials. The respective design guides for PVC or HDPE Pipe should be consulted for trench widths. The trench width and compaction requirements are different for rigid wall
pipe, such as ductile iron and concrete, versus flexible pipe such as PVC and HDPE.

q) Bedding and Backfill

During final design, consideration should be given to the types and depths of bedding and backfill materials, as well as to the strength of the HDPE pipe, earth loads, transient loads, hydraulic thrusts, trench width, and soil characteristics of the backfill when determining the depth of cover and HDPE pipeline thickness.

Conductive tracers should be specified in the backfill above the pipe to provide means for locating the pipeline in the future.

B. General Characteristics -- HDPE pipe for Gravity (drainage and sewer) Applications

1. The use of HDPE pipe for gravity applications is typically a corrugated pipe wall construction. Corrugated HDPE, abbreviated CPE, has been used for cross drains, culverts, and underdrains in roadways. The basic storm drain pipe is a single wall but as recently as 2006 the Federal Highway Administration changed the national construction and maintenance regulations to allow the use of alternative pipe materials and configurations. Double wall designs have been required for some highway loading or deeper burial requirements. The current gravity sewer design is the double wall that meets ASTM F2736. ASTM standards for the triple wall configurations are now under development. With the advent of profile and double walled HDPE pipe, there have been some recent manufacturer modifications to minimize the material deflection tendencies. The HDPE industry has also recently introduced corrugated, and steel ribbed, and triple walled HDPE pipe in an attempt to provide an even greater ‘stiffness’ factor necessary to provide better and more durable performance. However, some of the newer materials and profile wall configurations have been reported in several instances to have some difficulty in achieving a consistent degree of performance success.
2. CPE or profile wall storm pipe (corrugated exterior with smooth liner interior) has been installed in numerous instances over the last 5 to 10 years and continues to be permitted for some special highway and drainage applications. There are a number of ASTM test standards which apply to the design, installation and testing of these uses. The materials and methods used to install CPE continue to evolve and new lessons are being learned. As recently as 2011 ASTM standards were still under development to determine the stress crack testing protocols needed to empirically determine the desired design service life.

3. Primary highway standards for this application and use include:
   a) AASHTO PP63-09, Standard Practice for Pipe Joint Selection for Highway Culvert and Storm Drains;
   b) AASHTO MP20-10, Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, (12- to 36-in.) Diameter;
   c) ASTM F2306/F2306M, Standard Specification for 12 to 60 in. Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications;

4. Acceptance (municipal and DOT): Internet search found (18) current users with qualified acceptance or showing on-line specifications.

![Figure of Different types of CPE deformations observed – 10 state study](Source: Evaluation of HDPE Pipelines Structural Performance, University of Texas-Arlington, Center for Structural Research, November 2010)
5. In many instances, some structural performance issues have arisen due to a combination of factors. (Reference: 10 state study noted above) Premature distress has been seen, and has led to changes in products, profiles, installation procedures and inspection requirements over the last 5 to 10 years. The following states provide hundreds of pages of research investigations, findings, and recommendations:
      ftp://wydot-ftp.dot.state.wy.us/Engineering%20Services/Alt%20Pipe%20Committee/DRAFT%20CRITERIA%20FOR%20ALT%20POLICY%20SUBMITTED%20ON%20051712.pdf
   b. Very Recent North Dakota DOT 2012 study results: Good outcomes if installed properly. Reference:
      http://www.dot.state.mn.us/research/TS/2012/201227.pdf
   d. In most cases they advocate a careful approach to where these applications are being considered.

C. General Characteristics of HDPE pressure tubing for potable water applications

1. Current standards for this HDPE application and use include: AWWA C901-08, Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) 3 In. Through (76 mm) for Water Service. Note there are many other related newer plastic tubing types identified below.

2. There are numerous types and variations of ‘plastic tubing’ emerging onto the water service market, and it is possible that all are not equivalent in performance to the existing City standard, Type K copper. Some of the latest tubing specifications and standards are summarized as follows:

   HDPE: http://www.astm.org/Standards/D2737.htm 2012 updated
   HDPE, composite: http://www.astm.org/Standards/F1282.htm 2010 updated
   PEX, composite: http://www.astm.org/Standards/F2262.htm 2009 updated
   PVC, composite: http://www.astm.org/Standards/F2855.htm 2012 updated
   Polypropylene: http://www.astm.org/Standards/F2389.htm 2010 updated
3. There are dozens of manufacturers, not just for the various tubing materials, but also for the (2 inch and smaller diameter) fittings. Mechanical metallic type adapters appear to be the preferred method identified by this TM survey versus the electrofusion type. Many of the utilities allowing the use of HDPE material as noted above say that the service line itself is privately owned from the curb stop to the meter. The balance of the line is the responsibility of the utility. This fact apparently has had some bearing on their decision to allow the use of the material (not in the public right of way). One municipality recommends service line breakage insurance to homeowners, because the cost of replacement or repairs can be expensive. They also provide on-line information to advise them of the potential risks involved.

4. Oxidative Concerns and Testing: [http://hdpeoxidation.com/](http://hdpeoxidation.com/) Reference this website for disinfectants impacts as documented by the 2011 website for ‘Plastic Pipe Facts’. The recent test method update for evaluating oxidative resistance from ASTM can be found here: [http://www.astm.org/Standards/F2263.htm](http://www.astm.org/Standards/F2263.htm) also dated 2011, which shows four revisions since 2003 to this test method. Although there are concerns that have been raised by some in the water industry, there is no clear answer yet. Studies continue.

**Impacts on Operations and Maintenance**

A primary consideration with the addition of any alternative material is the impact on the City utility operations and maintenance. This is a significant reason why the TM telephone (and email) survey targeted operations personnel rather than the engineering personnel whenever possible. The perspective on the use of an alternate material is often different within operations than engineering. The engineering perspective typically looks for cost savings, life cycle costs and constructability issues, where operators look at ease of operation, minimizing repair occurrence, and ability to perform repairs quickly and cost effectively.

Some of the factors for the City to weigh when considering the allowance of an alternative material are:

- Creation of new design criteria and specifications
- Training for inspectors on proper installation methods
- Training for contractors on installation
- Training on potential damage from excavating next to the pipe.
Training for repairs
- Maintaining inventory of additional parts
- Knowing locations of material so parts are on hand
- Parts availability and training for repairs and connections
- Training for Engineers/Designers on proper design methods for material
- Knowing installed locations of material so designers know how to extend or connect to the material in the future

Among several of the TM survey respondents from the 39 utilities interviewed that had experience with HDPE, a reoccurring theme was voiced regarding the time required for operations staff to learn how to work with this material. This “learning curve” is complicated by the fact that continuing changes in the HDPE resin formulations may make the newer products and installation different from those installed earlier so the learning could be continuous. With the exception of HDD directional drilling installations, it was learned that a utility typically uses their own crews to install the HDPE taps that are necessary for installation and where special considerations exist for upgrading or replacing older pipeline systems.

One HDPE user surveyed stated that it has had a significant operational impact. For example, Colorado Springs, Colorado in 2000 began using HDPE pressure pipe for a water main replacement project in an area with a history of waterline breaks due to both highly corrosive soils and known for its hillside movement potential. With that original installation they experienced considerable difficulty with the HDPE electrofusion tap methods that were available from the manufacturer at the time, and have not gone back to direct tapping using electrofusion methods. However, they have since invested in maintenance training, procedures, methods and materials to successfully install and maintain and provide replacement parts and fittings for future HDPE installations and repairs utilizing newer saddle tapping methods. According to this utility, the initial operational impacts were significant, but the results have overall been positive. The pressure to find a different suitable material appears to have been substantial at the time and they have continued to make investments in their training and tooling so that their program for using and installing HDPE material continues to be carried out in a satisfactory manner. Cost information for the overall conversion was requested from this utility, but not provided at the time of this writing. For the difficult conditions and applications noted above, their preferred material continues to be HDPE, over PVC or ductile iron bell and spigot type installations.
There is a significant volume of both industry technical (PPI) and manufacturer’s product and design information and assistance currently available. Apparently there are newer resin materials and fitting types now available that are supposedly improved from that of the earlier versions (from two to five years ago). However, for municipal and pressure pipe use, many/most of the newer versions are reportedly only in the one to two years of experience range. Also, based on the survey interviews, not all product manufacturers have the same experience levels. This will have to be investigated further before any are placed on proposed material and supplier lists for City utility use.

It is also currently the case that most municipal-type piping contractors do not have the training or certifications needed to install HDPE pipe. Furthermore, even after proper training and certification, the contractor experience factor is the next most critical item that must be recognized, according to specifiers and users of the material that were surveyed. The consensus is that there are many details that must be attended to for a successful installation and the omission or inattention to any one of them can mean the difference between success and failure.

For this TM only those applications, as indicated later, that have the potential for having nominal impacts and/or the potential for positive effects will be recommended for use. In addition, conditional notes have been added to those recommended due to the fact that the consequences of failure at higher pressures and larger diameters will typically be greater than at lower pressures and diameters. Those applications that have the potential of having significant operational impacts, and/or which could include potential negative effects will not be recommended for acceptance or implementation. Therefore for purposes of this TM document they will fall into a category described as Do Not Recommend at this time.

Applications Summary – Advantages and Disadvantages

A. For Pressure Pipe applications-
   1. The general advantages of HDPE pipe materials can be summarized as follows:
      
      o Material appears to be minimally affected by normal corrosion potential from soil or water quality/chemistry. Early resin formulations noted concerns with premature pipe wall deterioration with extended exposure to
very high chlorine dosages, but newer resins are reportedly now more resistant.

- Suitable for HDD trenchless installations; fused joints do not require mechanical restraints
- Smooth wall provides improved friction factor for maintaining hydraulic capacity
- Good abrasion resistance properties
- Lower density translates into lighter weight allowing for ease in handling and installation
- In some instances installed cost may be competitive with other integral restrained PVC or ductile iron joint pipe systems for stream crossings, or rehabilitation of older piping systems. Material cost may also be competitive with other materials dependent on municipal/contractor demand and distributor availability.
- Short allowable bend radius allows for minor adjustments in alignment without fittings
- Development and availability of improved resin technologies within last 5 to 10 years
- Fewer joints compared to bell and spigot pipe material installations
- Viscoelastic properties of the material make it a good fit where flexibility and allowance for potential ground movement is needed
- Good surge pressure resistance features

2. The general disadvantages for HDPE pressure pipe materials use are:

- Requires special fittings, equipment and re-training of operators for installation and connection to existing pipe and fittings. Historical performance issues with taps, laterals, and branch lines due to potential for longitudinal movement of the pipe if not adequately restrained and confined. This is problematic for water distribution systems, but may not be so much for water transmission applications.

- Research for water use is ongoing as represented by this Water Research Foundation link: [http://waterrf.org/Pages/Projects.aspx?PID=4485](http://waterrf.org/Pages/Projects.aspx?PID=4485) The completion year indicated for the study is 2014. “The objective of this study is to determine the durability and reliability of large diameter high density polyethylene (HDPE) water mains, ranging from 24 to 48 inches internal diameter, as an economical alternative to other pipe materials. The project will focus initially on identifying key problems associated with modes, causes,
and rates of failure of HDPE water pipelines through a comprehensive literature search. Once these key problems are identified, durability and reliability of these pipes through surveys, experimental work, and case studies will be investigated. Research partners: WERF and EPA.”

- Wall thickness requires larger outside diameters compared to other pipe materials for an equivalent inside diameter. This will generally make it difficult for designers to design around one pipe size, for plans and specifications that allow either or both PVC and ductile iron pipe. Also it will be difficult to define ‘or equal’ for bidding purposes and misunderstandings/disagreements may occur.

- High coefficient of thermal expansion compared to other more commonly used materials. Temperature changes impact the pipe, and pipe movement can cause failures at fittings and laterals if not adequately restrained and reinforced.

- LTSH (Long Term Hydrostatic Strength) properties, and previous problems with slow crack propagation tendencies with former resin formulations means that more experience is necessary so that risk factors can be addressed with the newer and emerging resin technologies and additives. Until it is certain that this tendency has been significantly reduced or eliminated, it is recommended for this TM that low pressure applications only be considered for water transmission, force sewer (non-gravity) mains, or HDD type installations.

- Cannot be located in the field unless a tracer wire was initially installed and is operational.

- Material is relatively soft compared to other materials and has a higher potential for damage from third party excavations/drilling.

- Designs must incorporate additional or special considerations for buoyancy, loadings, trenching and backfill.

- Concerns with permeation of material in the presence of hydrocarbon compounds.

In summary, in our opinion there are a greater number of disadvantages than advantages at this point in time. When, or if in the future some of the disadvantages can be demonstrated to have been overcome, and shown to be based on significantly more field case histories, it may be appropriate to re-visit the recommendations herein for qualified and low risk applications for municipal pressure pipe systems (See paragraph F below).
B. For Gravity Pipe Applications (both drainage and sewer)

1. The general advantages of corrugated HDPE pipe materials (CPE configurations) typically available for sewer or drainage applications can be summarized as follows:
   
   o Lighter weight allows for easier material handling.
   o Typically initial installed cost is competitive with other materials, but life cycle costs should be taken into account.
   o Material is not affected by corrosive soils.
   o For smaller piping diameters less than 12 inch, more experience exists (AASHTO Standards). See related drainage tubing definitions and discussion in section D.
   o Newer product development and features are emerging for larger pipe (12 inch and greater) diameters.

2. The general disadvantages of HDPE corrugated pipe material (CPE configurations) for gravity use are:

   o A number of less than satisfactory case history results have been documented for many of the early drainage applications. (Reference: Evaluation of HDPE Pipelines Structural Performance, University of Texas-Arlington, Center for Structural Research, November 2010)
   o Material properties can be compromised due to high temperature, fire or accidental spill exposures.
   o Careful and deliberate bedding and backfill must be performed to avoid installations prone to premature distress or failure. Special inspections should be required.
   o Material buoyancy factor must be addressed in wet environments or in saturated soils.
   o Potential for heaving in frost situations.
   o Susceptible to material softening and weakness due to permeation if placed in hydrocarbon contaminated soils.
   o Insufficient case history for newer, yet stiffer, double and triple profile wall configurations.
   o Difficult to achieve similar and consistent deflection limits to date comparable to rigid materials for use in public right of ways and beneath roadways.
- Potential rapid loss of strength and catastrophic failure of pipe if small areas
  of bedding support are inadvertently removed or compromised.
- Special inspections/testing typically required during and after installation.

In summary, in our opinion more positive case history performance and
manufacturer and installation technique improvements are needed before a “Do
Allow” recommendation for either gravity sewer or storm drainage HDPE
applications can be given.

C. **For Water Service Line applications** (HDPE *General Advantages and Disadvantages*)
   1. A handful of municipalities were identified that have switched to allowing HDPE
      service lines (tubing) over the last several years:
      a. Two contact reports were made; Covington, WA and Redmond, WA.
         Two other municipalities, whose on-line specifications show that they
         allow did not return a call: Lexington, KY and Austin, TX.
      b. Rapid Valley Sanitary District (RVSD) in western South Dakota was also
         interviewed. They started allowing HDPE for service lines approximately
         one year ago. Given the limited experience timeframe, few problems
         have arisen so far. RVSD suggested that the quality of copper tubing for
         service lines is not what it was a few years ago and that is one of the
         reasons for the switch to HDPE. RVSD stated that they allow either K
         type copper or copper size OD 200 psi PE tubing. They use standard
         saddles with compression fittings with the primary difference between
         copper and HDPE being the stiffening insert required at the HDPE tubing
         end to accept the compression fitting.
      c. The material price difference was listed as one of the reasons for the
         utilities’ change to allowing HDPE tubing as copper prices have been
         increasing, especially over the last several years.
      d. Colorado Springs, Colorado has allowed this tubing but it has been met
         with some difficulty in certain situations. In addition, installers have
         indicated that it is not at all like other materials they have experience
         with. Colorado Springs Utilities is currently updating their current
         specifications and will re-issue them in 2014 with revised details.
      e. Per the operator survey results summarized earlier, five municipalities
         (out of 39) surveyed stated they allow use of HDPE tubing. One
         municipality stated that they discontinued use of HDPE due to leakage
problems at the fittings, and will instead consider polypropylene tubing as an alternative material.

f. City representatives have expressed some concern regarding older homes, where an unintended consequence to switching to HDPE away from copper might result in the residential electrical system becoming ungrounded, where this practice was allowed in some situations under older electrical or plumbing codes to ground to the buried copper piping to provide the ground protection.

Installation of HDPE tubing (from www.energicity.net)

2. Copper service as required by current City standard specifications is still the preferred material, and is recommended by this TM for 2 inch and smaller diameters. However, with an amendment to the current City Ordinance (current citation shown below) the door could be opened to allow more landowner say on the selection of materials other than copper that will meet acceptable potable water and certification requirements. (City of Rapid City Reference: Code of Ordinances—

13.08.060 Responsibility for costs—Indemnification of city.
All costs and expenses incident to the installation, connection and maintenance of the water service lines shall be borne by the owner. The owner shall indemnify the city from any loss or damage that may directly or indirectly be occasioned by the installation of the water service lines.) (Ord. 5794 (part), 2012)

3. For City consideration, the next illustration provides an example for a potential change in service line ownership. Currently in the City the property owner owns and is responsible for the entire service line from the house all the way to the water main which is often under or on the other side of the street. The
illustration shows the typical configuration for how several municipalities allowing HDPE use for service lines, split the responsibility of ownership.

Ownership of Water Service Lines
(source of illustration: Grand Rapids, Michigan Public Works Dept.)

In several cases, the municipalities contacted have chosen to continue to allow copper tubing to remain in their specifications, to be used within the street right of way area.

In summary, in our opinion more positive case history performance and manufacturer and installation technique improvements are needed before a “Do Allow” recommendation for HDPE water service line applications can be given.

D. For HDPE Roadway Edge Drains Applications (defined as Under-Drains per 2007 City Specifications) -- General Advantages and Disadvantages

1. Drainage tubing has been around and utilized in highway projects for more than a decade. Tubing is similar to: ADS Single Wall HWY Pipe Specification or equal, AASHTO M252 Type C in 4 inch, 6 inch, or 8 inch sizes or, ADS N-12® Plain End Pipe Specification or equal, AASHTO M252, Type S or SP, 4- through 10 inch. Corrugated polyethylene tubing shall conform to the requirements of ASTM F 405 and M 252-09 Standard Specification for Corrugated Polyethylene Drainage Pipe.

2. Because of the widespread allowance and service level performance for these smaller diameter corrugated HDPE drainage tubing materials along the edges of roadway surfaces among county and state highway departments, it is viewed as a time-tested HDPE application.

3. Along with corrugated PVC, corrugated HDPE is currently allowed by the 2007 City of Rapid City Standard Specifications. Reference: Section 64 Under-Drains
As follows: “Under-drain Pipe or Tubing
   1) Corrugated Polyethylene Drainage Tubing
   2) Profiled Wall PVC Pipe”

In our opinion, history and experience for both City and other jurisdictions indicates that this is a proven, time-tested material beneficial for pavement edge drainage purposes. If specified and installed properly it appears to have cost effective and design life benefits, and its use will be recommended to continue with this TM.

E. For HDPE Casing Pipe Applications (General Advantages and Disadvantages)
1. There were no internet hits or operators surveyed that indicated use of HDPE for casing pipe. The assumption is that smooth wall pipe is under consideration and this use would be for beneath roadways and railways.
2. There is no specific standard development or testing underway that we are aware of for use as casing pipes.
3. The limited internet search found no installations available for study.
4. General thoughts:
   a. Smooth wall pipe will deflect over time. (This result will likely occur even if filled up on inside with blown-in sand or lime powder because no assurance of entire volume being filled, or way of achieving compaction)
   b. Roadway settlement potential will be greater than with other rigid materials such as steel or concrete typically used for casings.
   c. CPE pipe could potentially be used for casing pipe, similar to B.1 and B.2 applications noted above, but this is not a time-tested application.
   d. If the casing deflects, no ability to pull out and repair carrier pipe as chocks, etc. will potentially be deformed.
   e. Leak potential for carrier pipe may be greater if significant deformation occurs, and if casing deforms and chocks cannot move, then road closure may be likely.
   f. Casing will have good corrosion resistance. However, if required, steel casings can be coated or otherwise cathodically protected if needed.
   g. Casing can be filled with CLSM to achieve greater structural rigidity and resist deflections over time, but the internet search found no case histories available to document the success of this method.
In summary, in our opinion more positive case history performance and manufacturer and installation technique improvements are needed before a “Do Allow” recommendation for HDPE casing pipe applications can be given.

F. For In-situ Rehabilitation and HDD Trenchless Methods, water transmission main, and sewer force main (all low pressure, including special gravity) Applications -- (General Advantages and Disadvantages)

Fused HDPE Pipe (from www.allenwatson.com)

1. These applications have had good success generally, and appear to have had a broad experience track record based on at least 10 – 20 years of experience across the U.S. and Canada. Note: A water transmission main is not the same as a water distribution main.

2. Experience with the newer and emerging resin(s) has not yet been gained, and since some standards are still in transition, it is recommended that low pressure applications be defined as below 160 psi maximum operating pressure (basis derived from older, Pressure Class, DR 11, 3408 resin type).

3. Use for In Situ rehabilitation (slip lining or pipe bursting) of older gravity trunk sewers in some cases has been seen. This might also include stream or highway crossings where casings are not required by the authority having jurisdiction.

To summarize our opinion, history and experience for many utility operators and installers indicates that this is a proven, time-tested material and method, and is beneficial when needed for these special purposes. If specified and installed properly it appears to have cost effective and design life benefits, and its use will be recommended for these various, and related, applications.
Recommendations

A. CITY APPLICATIONS USING HDPE ALTERNATE MATERIAL

Based on the information obtained in the operator surveys, internet search and more detailed follow-up contacts with other utilities, and comparison listings of general advantages and disadvantages of the material, it is recommended that HDPE be added to the City’s Design Criteria and Standard Specifications for the several City municipal applications listed below. Conditional notes have also been included as reviewed with and approved by City Staff. If accepted by the City, the City’s Infrastructure Design Criteria Manual and Standard City Specifications should be revised accordingly.

Further descriptive information regarding how these TM recommendations were arrived at, including recommendations for continuing education is included in the following paragraphs A) ii, iii, and iv and paragraph B).

i. The applications being recommended to allow HDPE as an alternate material are:

1) For water transmission mains that will not require taps or connections, now or in the future:

✓ “Do Allow” only under following conditions:

   a) Recommend City Staff initiate a change to City Ordinance to include a definition for ‘raw water transmission main’ and/or ‘water transmission main’ before implementing this recommendation to change the City design criteria and specifications to allow this application. Note: This recommendation is made in order to differentiate clearly between water distribution main and water transmission main applications as they have different recommendations for do allow or do not allow within this TM.

   b) Recommend for low pressure applications only: (Max. 160 psi operating pressure).

   c) Recommend for maximum 16 inch diameter (flow rate equivalent to ductile iron pipe size), consistent with size limitations for materials as specified by the City’s 2012 Infrastructure Design Criteria Manual.
2) For **sanitary sewer force mains**:  
✓ “Do Allow” only under following conditions:  
   a) Recommend for low pressure applications only: (Max. 160 psi operating pressure).  
   b) Recommend for maximum 16 inch diameter (flow rate equivalent to ductile iron pipe size), consistent with size limitations for materials as specified by the City’s 2012 Infrastructure Design Criteria Manual.

3) For **HDD trenchless installations**, horizontal directional drilling for stream or highway crossings where casings are not required, and *In Situ* pipe bursting and/or slip lining applications to rehabilitate older water or sewer trunk (without laterals or branch)main lines:  
✓ “Do Allow” only under following conditions:  
   a) Recommend for low pressure applications only: (Max. 160 psi operating pressure).  
   b) Recommend for maximum 16 inch diameter (flow rate equivalent to ductile iron pipe size), consistent with size limitations for materials as specified by the City’s 2012 Infrastructure Design Criteria Manual.  
   c) Recommend only for those approved by City Engineering where special installation methods are required to meet overall project goals.

4) For **water/sewer separation encasements**:  
✓ “Do Allow” only under following conditions:  
   a) Sizing and placement in accordance with current City design criteria and standard specifications for encasements, and as otherwise required by SD DENR.  
   b) For only those installations outside of roadway pavement areas.  
   c) Maintain minimum annular space between carrier pipe and encasement pipe.

5) For **roadway edge drains or, under drains**:  
✓ “Do Allow” only under following conditions  
   a) Recommended for less than or equal to 10 inch diameter perforated tubing for roadbed subgrade drainage purposes only.
ii. The following applications to allow HDPE as an alternate material are not recommended at this time:

- Water service lines.
- Water distribution mains.
- Sanitary sewer service laterals.
- Sanitary sewer gravity distribution mains.
- Storm or drainage pipe.
- Casing pipe.

iii. In general, the reasons taken individually or in combination for not recommending the above particular applications include the following:

- Some negative experiences reported by several of the utilities and operators contacted, particularly with regard to connections and taps for pressure piping systems.
- For many municipal applications, the HDPE piping industry is relatively young. Actual long-term municipal case histories are very limited upon which to base a decision for a significant investment into new materials, spare parts inventory, and expanded City staff responsibility, training time, re-tooling and record-keeping effort.
- Adoption of HDPE pipe for open-trench installations of municipal utilities has not yet become widely adopted locally, regionally, or nationally according to the survey results. Products are just beginning to emerge in the market, and experience is still limited.
- HDPE standards development and research continues to evolve and is clearly in transition. The HDPE industry has made recent strides towards adapting its products for municipal applications with improved resin formulations and associated product lines to better connect to fittings and other pipe materials for pressure applications. However, this also implies that for the fewer number of municipal applications that have been and are being attempted elsewhere, many of these installations have not yet been sufficiently time-tested.
- For non-pressure CPE applications, emerging research indicates ‘proceed with caution’ type recommendations, for example from the adjacent DOTs surrounding South Dakota, including Minnesota, North Dakota, and Wyoming which have a similar climate and soil type. Even though a few municipalities around the U.S. have recently (within the last 3 years) opened
their specifications to allow CPE for larger diameter storm pipe use, it is not in our opinion as time-tested at this point in time for this TM, especially for those installations located beneath roadway subgrades. Standards and specifications development for the newer resin materials and profiles (which now also includes wire reinforced ribs and triple profile wall configuration options) is just now emerging and/or in transition. More case history performance and time-tested experience is needed before a recommendation for HDPE use can be given for this municipal application.

- Trial and error experience continues to be gained by many installers/suppliers in an effort to determine the best methods to install and connect HDPE materials to more traditional types of municipal and highway/street drainage pipes, fittings, services, and appurtenances. This is not a disadvantage per se, but we recommend the City take a conservative approach and allow the best methods and products to emerge from a relatively young municipal industry. As new industry standards also emerge, then those along with the latest experiences are likely to be shared at training conferences, etc. with potential future customers, both installers and users.

- It is advisable that City staff learn from others experiences if and where possible (both positive and negative), to better understand the cost and risk factors, and avoid unnecessary negative consequences before proceeding with these alternate material applications. See paragraph B. Continuing Education Recommendations below.

iv. The following discussion provides an outline synopsis of how the different application recommendations were considered (weighted) for this TM showing that the predominant basis comes from Operator and User Survey Responses with the follow-up detailed contact reports. The secondary basis comes from the Internet Search and Status of Standards Development.

**TM Recommendations Weighting**

**70% based on Initial 39 Operator/User Survey Responses and Contacts;**

- Types and trends of applications, national contacts and response.
- Both Allow and Do Not Allow responses received, but not always a definite yes or no.
- Not sufficiently time-tested for municipal applications, by some comments.
- Operations impacts, Contractor training, Engineer familiarity issues.
• Some less than satisfactory experiences reported.
• Attendance at ASCE and AWWA Water Conference, and talking with Operators.
• City Comments during Workshop Sept. 2012.
• Denver Wastewater; recent 2012 pipe bursting and slip lining specifications added.
• Colorado Springs Utilities; detailed discussions and contact reports with 2 people (allowance for water transmission, and sanitary FM applications). Amended specifications due 2014.
• Rapid Valley Sanitary District; use of material for water service lines.
• User Learning Curve comments; more training, re-tooling, and spare parts.
• City’s draft TM review comments.

30% based from Internet Search and Status of Technical Standards Development;
• Recent development and change history for ASTM HDPE Standards.
• Detailed technical comparison charts and tables provided in the Appendix.
• Recent DOT studies and reports, for CPE materials; (WY, MN, ND).
• PVC and HDPE water pipe history comparisons, with dates and durations.
• WRF research report for municipal use due out 2014.
• AWWA C-906 revisions due, but not out yet.
• Trenchless Technology Magazine HDD survey results.
• PPI Industry and Manufacturer website case history and Q/A information.

100%

B. CONTINUING EDUCATION

For the City’s consideration, it is recommended that Public Works staff develop an action plan beyond this TM effort towards educating City operations and engineering staff about HDPE and HDD trenchless applications more specifically with a potential for deriving benefits for the recommended municipal applications indicated:

1. Consider limited travel for key City staff to hear first-hand accounts from current users of the material in Colorado or Kansas who have specific experiences and perspectives from a design, installation and maintenance perspective. Nearby municipalities such as Denver or Colorado Springs would be especially good candidates for consideration. To Consider: Colorado Springs, CO made the decision to try HDPE for special application pressure pipe use (in 2000) and did not adopt it into their specifications until 2009. They stated that they went through a “significant learning curve” for
their designers, contractors and operators and continue to allow its use as an alternate material on a case by case basis. They stated that HDPE is not necessarily a lower cost option compared to PVC. They are finding most contractor’s/developers do not opt to use HDPE pipe for traditional water distribution installations, but will use it when encouraged to do so for the specialty applications, as previously noted. Denver’s most recent standards and specifications for Horizontal Directional Drilling, pipe bursting, and slip lining allowing the use of HDPE materials is dated March 28, 2012 and December 4, 2012. Denver’s municipal group may be another resource available.

2. Consider on-line courses, webinars or attending seminars regarding use of the material.

3. Obtain hands on training from equipment, fitting, and tooling manufacturers and/or suppliers.

4. Perform a study of the potential investment options for re-tooling and inventory of parts/materials which will either be born directly by the Utility Group itself, or indirectly through encouraging specialty contractors and suppliers to take on the risk associated with the use of these materials, and providing the tools and expertise that may be needed to handle emergency replacements or repairs when called upon.

5. Set up in-house training seminars for consultants, City staff, inspectors, general public, and private contractors to attend.


The DVD illustrates the characteristics of PE pipe used in water supply. Areas of discussion include:

- Advantages, disadvantages, and concerns.
- Thermal effects and weathering.
- Guideline for proper transportation, receiving, unloading, inspection, and storage.
- Working characteristics.
- Basic installation procedures and considerations.
- Bedding and backfill requirements.
- Basic pipe repair.
- Maintenance, testing, and record-keeping.
6. In addition, City Staff may request from a combination of consultant(s) and industry representatives an in-depth implementation plan and detailed specifications for any one of the specific applications recommended that it desires to pursue. As noted at the outset of this TM, the effort expended for this report was not intended to be an exhaustive study of HDPE to recommend all of the various details required to implement and include the material for each specific City or municipal application.

7. An in-depth implementation plan might include the following topics with more specificity and detail as required for any one of the applications:

   i) Recommended phased implementation and timeline plan.

   ii) Provide a list of contacts, references and resources specific to the particular application.

   iii) Provide components of a recommended minimum training program (or pipe school) for:

        a) Designers

        b) Inspectors

        c) Installers

        d) Repair crews.

   iv) Provide a list of current manufacturers for further evaluation/acceptance.

   v) Draft a list of proposed suppliers for City approval, with their certifications plans/details for file.

   vi) Provide an independent and/or city inspector qualifications/certification plan.

   vii) Develop a detailed specification, compatible with other features and requirements of the overall system, for the City Standard Specifications.

   viii) Develop minimum design criteria to be used by engineers and designers for adoption into the City’s Infrastructure Design Criteria Manual.

   ix) The cost to implement the above educational strategies and planning resources is currently unknown. An inquiry was made to obtain this information from at least one utility as part of the TM efforts, but the information was not forwarded.
FINAL SUMMARY (Recommendations in Abbreviated Table Format)

The following table provides a visual representation for the applications and corresponding attributes for a Do Recommend or Do Not Recommend at this time: A check mark label represents a positive indicator for the particular attribute of the municipal application under consideration. If an attribute is not checked, it indicates either unknown or positive impact potential cannot be confirmed. Critical qualifiers for the recommended HDPE applications shown in the Table are provided in paragraph A) above. The abbreviated attribute definitions are provided below. This table should only be used when taken and interpreted together with the other discussion provided in the recommendations portion of this TM. A full discussion for each application and its attributes is found in the body of this TM.

Attribute Explanation Key:

1. A positive Operational Impacts label indicates minimum time, cost or risk exposure for City operations and maintenance staff to adopt this application. This includes compatibility with existing materials and systems. Also cost considerations for training and re-tooling (for taps), spare parts, etc. - special maps of system installations for emergency response to breaks, leaks, etc.

2. A positive Designer Impacts label indicates minimum time or risk exposure for City Consultants or Engineers to adopt this application.

3. A positive Contractor Training/Retooling Impacts label indicates minimum time, cost or risk exposure for City Contractors and Suppliers to adopt this application.

4. A positive Service Life - Case History label indicates that there is sufficient case history developed for this application. A time-tested application would typically look for a successful performance time period of 10-20 years or more.

5. A positive Standards Compliance/Development label indicates that there has been previous and ongoing Standards Development underway for this application.

6. A positive Favorable Capital Costs label indicates that there can be both favorable economic and life cycle outcomes for this application.
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<th>Designer Impacts</th>
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<td>Horizontal Directional Drilling (HDD) applications (e.g., stream and highway crossings)</td>
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<td>In-situ lining to repair existing infrastructure piping (water, sanitary, storm sewer)</td>
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APPENDICES

A) PHONE SURVEYS
B) CONTACT REPORTS
C) PIPE SIZE AND MATERIAL COMPARISONS
D) INTERNET SEARCH DATA
E) PRESSURE CLASS SELECTION PER AWWA C906
F) AWWA C906 Standard Notice
APPENDIX A

PHONE SURVEYS
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<th>Utility Name</th>
<th>YES</th>
<th>NO</th>
<th>Water</th>
<th>Service Lines</th>
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|        | 13  | 3   | 5   | 3   | 4   | 4   | 11   | 26   | 8   | 33.33% Don't use HDPE but 50% have trenchless | 66.67% 20.51% use for storm drain of responses use HDPE for Trenchless |

Note: The numbers represent the percentage or frequency of certain responses.
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: __________________________________________________________

Contact Person: ________________ Position Title: __________________________

E-mail: ___________________________ Phone #: ____________________________

1. Does the utility allow HDPE pipe? Yes_____ No_____ If YES,  
   a. For water: service lines, distribution or transmission ________________  
   b. For wastewater: laterals, gravity or force mains. _________________  
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) ________  
   d. Storm Drains ___________________________________________________  
   e. Other Services: (Casing, Roadway Drain) ____________________________  
   f. Are there any limits or restrictions to its use in the system? Yes ____ No____  
   g. Does the utility allow PVC as an alternate or equal? Yes ____ No____  
      What services is it allowed? ________________________________

2. Is there a standard specification or guideline for use? Yes ____ No____  
   a. When (about) was it approved for use? _____________________________  
   b. Why was it approved for use in the system? __________________________

3. Has training been provided to city maintenance, inspectors, engineering or others  
   for working with HDPE? Yes ____ No ____ Describe: _______________________

4. When allowed was there an impact to operations and maintenance for repairs,  
   inventory of parts and equipment? Yes _____ No ______  
   a. Describe impacts: ________________________________________________  
   b. Has the cost effectiveness been evaluated? Yes ____ No ____  
   c. How often is it used or bid as an option? Rarely ____ Regularly ____  
   d. What is your opinion of HDPE?  
   e.  
      □ Satisfactory  □ Neutral  □ Unsatisfactory  
      Comments: ______________________________________________________
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: ____________________________

City of Ann Arbor

Contact Person: Brian Steglitz, P.E. Position Title: Sr. Utilities Engineer

E-mail: bsteglitz@a2gov.org Phone #: ph. (734) 794-6426 ext. 43905

1. Does the utility allow HDPE pipe? Yes __X__ No ______ If YES,
   a. For water: service lines, distribution or transmission __distribution__
   b. For wastewater: laterals, gravity or force mains. __all__
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) ________
      Yes
   d. Storm Drains ______ Yes
   e. Other Services: (Casing, Roadway Drain) ______ No
   f. Are there any limits or restrictions to its use in the system? Yes __X__ No__
   g. Does the utility allow PVC as an alternate or equal? Yes __X__ No ______ What services is it allowed? ________________________________

2. Is there a standard specification or guideline for use? Yes ____ No __X__
   a. When (about) was it approved for use? ________________________________
   b. Why was it approved for use in the system? ________________________________

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes __X__ No ____ Describe: ________________________________

4. When allowed was there an impact to operations and maintenance for repairs, inventory of parts and equipment? Yes _____ No ______
   a. Describe impacts: ________________________________
   b. Has the cost effectiveness been evaluated? Yes _____ No ______
   c. How often is it used or bid as an option? Rarely ____ Regularly ______
   d. What is your opinion of HDPE?

☐ Satisfactory  ☑ Neutral  ☐ Unsatisfactory
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Charleston Commissioners of Public Works (Charleston Water System)
City of Charleston, SC

Contact Person: Russell Huggins Position Title: Director of Engineering

E-mail: hugginsrf@charlestonpw.com Phone #: 843-727-6879

1. Does the utility allow HDPE pipe? Yes X No __________ If YES,
a. For water: service lines, distribution or transmission Conditionally
b. For wastewater: laterals, gravity or force mains. Force Mains
HDD
d. Storm Drains N/A
e. Other Services: (Casing, Roadway Drain)

f. Are there any limits or restrictions to its use in the system? Yes X No
We do not allow water services off of HDPE

g. Does the utility allow PVC as an alternate or equal? Yes X No __________
What services is it allowed? We are a DIP water company. However, we
do allow HDPE for HDD. When conditions warrant, we will allow fusible
PVC in lieu of HDPE.

2. Is there a standard specification or guideline for use? Yes X No __________
a. When (about) was it approved for use? 15 years
b. Why was it approved for use in the system? Primarily for river crossings.
Better protection from river scour, damage from boats, corrosion, etc.

3. Has training been provided to city maintenance, inspectors, engineering or others
for working with HDPE? Yes ____ No X. Describe: Since HDPE is limited to HDD,
this is specialty contractor performed.

4. When allowed was there an impact to operations and maintenance for repairs,
inventory of parts and equipment? Yes _____ No X

a. Describe impacts: Minimal impacts due to the fact that HDPE is limited to
river/wetland/road crossing installed by HDD. Plus the fact that we do not
allow services off of HDPE. We have found services can easily pull out
and are subject to leaking.

b. Has the cost effectiveness been evaluated? Yes ____ No X

c. How often is it used or bid as an option? Rarely ____ Regularly X
d. What is your opinion of HDPE?

☐ Satisfactory  ☐ Neutral  ☐ Unsatisfactory

Comments: Again, Charleston Water System is a DIP water company. However, our service area has a lot of wetlands and river crossing where the preferred method of installation is HDPE. Primarily these are larger mains constructed as part of our Capital Program. We have long and successful history using HDPE for HDD installation. It has also proven effective for wastewater Force Mains.
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Region of Durham

Contact Person: Dale R. Clemens  Position Title: Works Technician

E-mail: dale.clemens@durham.ca  Phone #: 1-800-372-1102 ext 3413

1. Does the utility allow HDPE pipe? Yes ___ No ___ If YES,
   a. For water: service lines, distribution or transmission No
   b. For wastewater: laterals, gravity or force mains. Open siphons only.
      meeting CSA B137.1-05, AWWA C906-07
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) ___
      meeting AWWA C906-07 Pressure Class DR11 HDD Crossings
      only (for Water Systems)
   d. Storm Drains ___ maximum 900mm diameter meeting CSA B182.8-11
   e. Other Services: (Casing, Roadway Drain) ____________________________
   f. Are there any limits or restrictions to its use in the system? Yes ___ No
      standards listed above
   g. Does the utility allow PVC as an alternate or equal? Yes ___ No ___
      What services is it allowed? Watermain, sanitary sewer main, storm
      sewer main.

2. Is there a standard specification or guideline for use? Yes ___ No ___
   a. When (about) was it approved for use? 1980's ___________________
   b. Why was it approved for use in the system? Same time
      __________________________

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes ___ No ___ Describe: Information seminars
   When allowed was there an impact to operations and maintenance for repairs,
   inventory of parts and equipment? Yes ___ No ___
   a. Describe impacts: ___________________________________________________
   b. Has the cost effectiveness been evaluated? Yes ___ No ___ (see
      comment below)
c. How often is it used or bid as an option?  Rarely ___ Regularly _x___

d. What is your opinion of HDPE?

☐ Satisfactory  ☐ Neutral  ☐ Unsatisfactory

Comments: Open competition between contractors and distributors as with all approved products in order to achieve most cost effective material choices.

________________________________________________________

________________________________________________________
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: **CITY OF FARGO, ND**

Contact Person: **BRENDA DEETZ/NATHAN**  Position Title: **ENGR. DIVISION**

E-mail: ______________________________ Phone #: 701-241-1545

1. Does the utility allow HDPE pipe? Yes ___ No X ___ If YES, PVC outside ROW
   a. For water: service lines, distribution or transmission COOPER
   b. For wastewater: laterals, gravity or force mains. PVC
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining)
   d. Storm Drains RIBBED ALLOWED
   e. Other Services: (Casing, Roadway Drain)
   f. Are there any limits or restrictions to its use in the system? Yes ___ No ___
   g. Does the utility allow PVC as an alternate or equal? Yes X ___ No ___
      What services is it allowed? TRENCHLESS RE CROSSING FPVC

2. Is there a standard specification or guideline for use? Yes ___ No X ___
   a. When (about) was it approved for use? ______________________________
   b. Why was it approved for use in the system? ______________________________

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes ___ No ___ Describe: ______________________________

4. When allowed was there an impact to operations and maintenance for repairs,
   inventory of parts and equipment? Yes ___ No ___
   a. Describe impacts: ______________________________
   b. Has the cost effectiveness been evaluated? Yes ___ No ___
   c. How often is it used or bid as an option? Rarely ___ Regularly ___
   d. What is your opinion of HDPE?
      [ ] Satisfactory  [ ] Neutral  [ ] Unsatisfactory
      Comments: ______________________________
Name of Utility: City of Grand Rapids – Water and Environmental Services Depts.

Person: Arden Postma Position Title: Hydraulic Engineer

E-mail: apostma@gocity.us Phone #: 616-456-4201

1. Does the utility allow HDPE pipe? Yes __X__ No ______ If YES,
   a. For water: service lines, distribution or transmission transmission mains
      in select circumstances such as large river crossings
   b. For wastewater: laterals, gravity or force mains. ___Force mains only___
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) ___
      directional drill for force mains and river crossings
   d. Storm Drains ___no_______
   e. Other Services: (Casing, Roadway Drain) ___no_______

   f. Are there any limits or restrictions to its use in the system? Yes __X__ No__

   g. Does the utility allow PVC as an alternate or equal? Yes ___ No __X__
      What services is it allowed? ___PVC can be used for sewer Laterals___

2. Is there a standard specification or guideline for use? Yes ____ No __X__
   a. When (about) was it approved for use? ________ The usage of HDPE
      has been very limited, so the specs that have been used are typically
      project based
   b. Why was it approved for use in the system? _______Specific application

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes ___ No __X__ Describe:_______________________

4. When allowed was there an impact to operations and maintenance for repairs,
   inventory of parts and equipment? Yes __X__ No ______
   a. Describe Impacts: Staff is not familiar with product, so repairs may need
      to be contracted out. With an additional material type, it may require
      additional materials to be stored in inventory.
   b. Has the cost effectiveness been evaluated? Yes ____ No __X____
   c. How often is it used or bid as an option? Rarely __X__ Regularly ______
   d. What is your opinion of HDPE?
☐ Satisfactory  ☑ Neutral  ☐ Unsatisfactory

Comments: Overall, HDPE is generally not used except for specific projects within both Water and ESD. Water services are Type K copper up to the curb box and then, on the private side of the curb box, can be any material that is approved by the State of Michigan Plumbing Code for water services. Sewer laterals can be PVC. Water has looked at HDPE for pipe bursting as a potential cheaper alternative to replacing watermains with Ductile Iron, but we are not in favor of this process at this time (taps to main are an issue).
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Scott Green  City of Independence  
Contact Person: Shar Dilmaghani  Position Title: Const. Mgr.
E-mail:  Phone #: 325-7611

1. Does the utility allow HDPE pipe? Yes  No   If YES,
a. For water: service lines, distribution or transmission  
   No
b. For wastewater: laterals, gravity or force mains.  No

c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining)  
   Not
d. Storm Drains  up to 74" under roadway, Someone Picked Gas  
   Down and Lft the pipe
e. Other Services: (Casing, Roadway Drain)

f. Are there any limits or restrictions to its use in the system? Yes ___ No ___

g. Does the utility allow PVC as an alternate or equal? Yes  X  No ___
   What services is it allowed?  or other   MTL1

2. Is there a standard specification or guideline for use? Yes ___ No  X  APWA  
   TRENCH DETAIL
   a. When (about) was it approved for use?
   b. Why was it approved for use in the system?

3. Has training been provided to city maintenance, inspectors, engineering or others  
   for working with HDPE? Yes ___ No  X  Describe:

4. When allowed was there an impact to operations and maintenance for repairs, 
   Inventory of parts and equipment? Yes ___ No  X
   a. Describe Impacts:
   b. Has the cost effectiveness been evaluated? Yes ___ No ___
   c. How often is it used or bld as an option? Rarely ___ Regularly ___
   d. What is your opinion of HDPE?
      X Satisfactory  Neutral  Unsatisfactory
      Comments: Storm Drain
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Johnson County Wastewater, Kansas
Contact Person: Gordon Rames
E-mail: gordon.rames@cw.org

1. Does the utility allow HDPE pipe? Yes ___ No _____ If YES,
   a. For water: service lines, distribution or transmission N/A (WaterOne does and has
   b. For wastewater: laterals, gravity or force mains. Yes _____ No _____
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) _____ Used
      for Pipe bursting and HDD for Low pressure sewers (do not allow HDD for gravity
      (yet) __________________________________________
   d. Storm Drains N/A __________________________________________
   e. Other Services: (Casing, Roadway Drain) _____ One case of direction drilling casing for
      low pressure sewer (close proximity of water line) __________
   f. Are there any limits or restrictions to its use in the system? Yes X No _____
      Internal bead must be removed for gravity mains __________
   g. Does the utility allow PVC as an alternate or equal? Yes X No _____ What
      service is it allowed? No PVC on low pressure sewers __________

2. Is there a standard specification or guideline for use? Yes ____ No ___
   a. When (about) was it approved for use? 1999 for Low pressure sewers and
      officially 2010 for Construction and Material Specifications _______
   b. Why was it approved for use in the system? Low pressure sewers- no joint,
      durability, directional drilling. Service line- no joints durability, long service lines
      (greater than 100 ft) Mains- no joints, durability, water tight
      Force Mains- no joints, restrained, durability ____________________________

3. Has training been provided to city maintenance, inspectors, engineering or others for working
   with HDPE? Yes __ No ___ Describe: Suppliers have provided demonstrations, and
   informational meeting to all (inspectors, contractors, engineers) __________________________
4. When allowed was there an impact to operations and maintenance for repairs, inventory of parts and equipment? Yes _X_  No ______
   a. Describe impacts: Bought material for emergency repairs for low pressure sewers (couplings and extra pipe)
   b. Has the cost effectiveness been evaluated? Yes ___ No _X___
   c. How often is it used or bld as an option? Rarely _X_ (specific gravity applications) Regularly _X_ (all lps) and
   d. What is your opinion of HDPE?

☐ Satisfactory  ☐ Neutral  ☐ Unsatisfactory

Comments: ____________________________________________________________________________

Like all things HDPE has its place

From: Livingston, Bryon [mailto:LivingstonB@BV.COM]
Sent: Thursday, August 09, 2012 3:44 PM
To: Rames, Gordon, JCW
Subject: Use of HDPE

The city of Rapid City South Dakota has asked Black & Veatch to help them to evaluate if they should allow HDPE in their standard specification and for what services. They asked us to contact other clients to see if they are using HDPE and if so what has been their experience. I would appreciate your input, if you could take a couple minutes and respond to these 4 questions.

Please feel free to provide any comments or call me if you have any questions.

Thanks,

Bryon Livingston, P.E.* | Burled Infrastructure Department
Black & Veatch | 8400 Ward Parkway, KC, MO 64114
+913-485-3368 x | livingstonb@bv.com
*Licensed in OK, KS, MO
Building a World of Difference.
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Jordan Valley Water Conservancy District
Contact Person: Shane Swensen
Position Title: Engineering Department Manager
E-mail: shanes@jvwd.org
Phone #: 801-565-4300

1. Does the utility allow HDPE pipe? Yes if YES,
   a. For water: service lines, distribution or transmission: transmission
   b. For wastewater: laterals, gravity or force mains. n/a
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) HDD
   d. Storm Drains n/a
   e. Other Services: (Casing, Roadway Drain) no
   f. Are there any limits or restrictions to its use in the system? Yes – if the pressure of the line is high a very thick HDPE wall becomes unpractical and more difficult to construct (egg shaped pipe).
   g. Does the utility allow PVC as an alternate or equal? Sometimes
   h. What services is it allowed? More common in the distribution sizes

2. Is there a standard specification or guideline for use? No
   a. When (about) was it approved for use?
   b. Why was it approved for use in the system?

3. Has training been provided to city maintenance, inspectors, engineering or others for working with HDPE? Yes Describe: Blue stake pipeline locators were taught the soft nature of the material in order to explain to an contractor excavating around the pipeline.

4. When allowed was there an impact to operations and maintenance for repairs, inventory of parts and equipment? No
   a. Describe impacts: _Has the cost effectiveness been evaluated? Yes
   b. How often is it used or bid as an option? Rarely
   c. What is your opinion of HDPE?
      Satisfactory
      Comments: HDPE has a major advantage allowing for fabrication of field fittings at any angle.
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: City of Lawrence, Kansas Utilities – Water and Sanitary Sewer

Contact Person: Philip E. Ciesielski  Position Title: Assistant Utilities Director

E-mail: pciesielski@lawrenceks.org    Phone #: 785-423-7114

1. Does the utility allow HDPE pipe? Yes Limited  No _____  If YES,
   a. For water: service lines, distribution or transmission service lines ½” – 2”
   b. For wastewater: laterals, gravity or force mains. Have used on one 16”
     gravity interceptor installed via pipe reaming.
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) _______

   d. Storm Drains ________________________________
   e. Other Services: (Casing, Roadway Drain) ______________________

   f. Are there any limits or restrictions to its use in the system? Yes X  No _____
      We do not have any standardize use of HDPE other than the water
      service line applications noted above. The other use was based on the
      individual projects particular design and construction.
   g. Does the utility allow PVC as an alternate or equal? Yes X  No ______
      What services is it allowed? City’s standard specifications allow PVC and
      ductile iron for watermains 12” and smaller; gravity sanitary sewers and
      forcemains 8” – 18”. Other sizes are evaluated on a project by project
      basis for the appropriate material.

2. Is there a standard specification or guideline for use?  Yes X for the water service
   lines  No _____
   a. When (about) was it approved for use? ______ 2011 __________
   b. Why was it approved for use in the system? Successful pilot installations
      and increasing cost of copper services.

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes ___  No X  Describe: __________________________

4. When allowed was there an impact to operations and maintenance for repairs,
   inventory of parts and equipment? Yes _X_  No ______
   a. Describe impacts: Additional inventory items; fittings and repair materials.
   b. Has the cost effectiveness been evaluated? Yes ___  No _X_
c. How often is it used or bid as an option? Rarely _X_ Regularly __

d. What is your opinion of HDPE?

☐ Satisfactory  _X_ Neutral  ☐ Unsatisfactory

Comments: Not enough experience with the material for a performance based assessment on distribution and collections system pipe. We have not had any issues with its use for water service lines and the one 16" interceptor sewer installation was a successful project.
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: **City of Lee's Summit, Water Utilities**

Contact Person: **Tim Mathes** Position Title: **Supervisor**

E-mail: **Tim.Mathes@cityofls.net** Phone #: **913-10-8065**

1. Does the utility allow HDPE pipe? Yes _X_ No ___ If YES,
   a. For water: service lines, distribution or transmission [ ] Yes [ ] No
   b. For wastewater: laterals, gravity or force mains. [ ] Yes [ ] No
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) [ ] Burst [ ] HDPE
   d. Storm Drains [ ] Yes [ ] No
   e. Other Services: (Casing, Roadway Drain) [ ] Yes [ ] No

   f. Are there any limits or restrictions to its use in the system? Yes _X_ No [ ]

   g. Does the utility allow PVC as an alternative or equal? Yes _X_ No ___
      What services is it allowed? [ ] PVC for Trenchless

2. Is there a standard specification or guideline for use? Yes _X_ No ___
   a. When (about) was it approved for use? [ ] Recently
   b. Why was it approved for use in the system?

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes _X_ No [ ] Describe:

4. When allowed was there an impact to operations and maintenance for repairs,
   inventory of parts and equipment? Yes _X_ No ___
   a. Describe impacts: [ ] Repair Concerns
   b. Has the cost effectiveness been evaluated? Yes _X_ No [ ]
   c. How often is it used or bid as an option? Rarely _X_ Regularly __
   d. What is your opinion of HDPE?
      [ ] Satisfactory [ ] Neutral [ ] Unsatisfactory
      Comments: [ ] Like HDPE, CHLORINATION WATER ISSUE
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: CITY OF LIBERTY, MO
Contact Person: Bryan Hess Position Title: Asst. Dir. of PW
E-mail: bhess@ci.liberty.mo.us Phone #: 816-439-4502

1. Does the utility allow HDPE pipe? Yes [X] No [ ] If YES,
a. For water: service lines, distribution or transmission [distribution: none in service.]
b. For wastewater: laterals, gravity or force mains.
c. Trenchless Installations (HDD crossings, Pipe Bursting, Lining) [all]
d. Storm Drains [all]
e. Other Services: (Casing, Roadway Drain) [NA]
f. Are there any limits or restrictions to its use in the system? Yes [ ] No [ ]
g. Does the utility allow PVC as an alternate or equal? Yes [X] No [ ] What services is it allowed?

2. Is there a standard specification or guideline for use? Yes [X] No [ ]
a. When (about) was it approved for use?

2. Why was it approved for use in the system? [Diversity]

3. Has training been provided to city maintenance, inspectors, engineering or others for working with HDPE? Yes [ ] No [X] Describe;

4. When allowed was there an impact to operations and maintenance for repairs, inventory of parts and equipment? Yes [ ] No [X]
a. Describe Impacts:

b. Has the cost effectiveness been evaluated? Yes [ ] No [X]
c. How often is it used or bld as an option? Rarely [ ] Regularly [X]

4. What is your opinion of HDPE?

[X] Satisfactory [ ] Neutral [ ] Unsatisfactory

Comments: Mostly used in storm water applications, less expensive and easier to handle for install.
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: North Texas Municipal Water District

Contact Person: Jeff Hogan Position Title: Professional Engineer

E-mail: jhogan@ntmwd.com Phone #: 972-442-5405

1. Does the utility allow HDPE pipe? Yes ___X___ No ______ If YES,
   a. For water: service lines, distribution or transmission ______ no
   b. For wastewater: laterals, gravity or force mains. _______ Yes, all
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) ______ Yes, all
   d. Storm Drains _______ yes
   e. Other Services: (Casing, Roadway Drain) _______________________
   f. Are there any limits or restrictions to its use in the system? Yes ___X___ No ______ not with water systems
   g. Does the utility allow PVC as an alternate or equal? Yes ___X___ No ______
   What services is it allowed? ______ Water and wastewater

2. Is there a standard specification or guideline for use? Yes ___ No ___X___
   a. When (about) was it approved for use? _______________________
   b. Why was it approved for use in the system? _______________________

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes ___ No ___X___ Describe: _______________________

4. When allowed was there an impact to operations and maintenance for repairs,
   inventory of parts and equipment? Yes ___ No ______
   a. Describe impacts: _______________________
   b. Has the cost effectiveness been evaluated? Yes ___ No ______
   c. How often is it used or bid as an option? Rarely ___ Regularly ___
   d. What is your opinion

   ___ of HDPE? ___ Satisfactory ___ Neutral ___ Unsatisfactory

Comments: Maint. staff is not set up to work on HDPE, but we will allow
it in our san. sewer specs. Personally, I have worked with HDPE in a few
W and WW applications while at the City of Wichita Falls, TX. Occasions
were HDD in a tight easement (water) and HDD gravity and siphon lines.
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: MOUNT PLEASANT WATER WORKS

Contact Person: DAVID NIESSER Position Title: ENGINEERING MANAGER

E-mail: D NIESSER @ MPW ONLINE.COM Phone #: 843-971-7586

1. Does the utility allow HDPE pipe? Yes ☑ No ☐ If YES,
   a. For water: Service lines, distribution or transmission
   b. For wastewater: laterals, gravity or force mains
   c. Trenchless Installations. (HDD crossings) Pipe Bursting, Lining
   d. Storm Drains
   e. Other Services: (Casing, Roadway Drain)

   f. Are there any limits or restrictions to its use in the system? Yes ☐ No ☑

   g. Does the utility allow PVC as an alternate or equal? Yes ☑ No ☐
      What services is it allowed? ALL

2. Is there a standard specification or guideline for use? Yes ☑ No ☐
   a. When (about) was it approved for use?
   b. Why was it approved for use in the system? RIVER WATER WAYS CROSSINGS

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes ☐ No ☑ Describe:

4. When allowed was there an impact to operations and maintenance for repairs,
   inventory of parts and equipment? Yes ☑ No ☐
   a. Describe Impacts: USE ON WATER DISTRIBUTION AS TELAL
   b. Has the cost effectiveness been evaluated? Yes ☑ No ☐
   c. How often is it used or bid as an option? Rarely ☐ Regularly ☑
   d. What is your opinion of HDPE?

   ☑ Satisfactory ☐ Neutral ☐ Unsatisfactory

   Comments: WE USE FOR WATER CROSSINGS, WATER TRANSMISSION (LIMITED USE) IN FORCE MAINS.
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Padre Dam Municipal Water District

Contact Person: Michael Hindle Position Title: Civil Engineer

E-mail: MHindle@padre.org Phone #: 619-256-4632

1. Does the utility allow HDPE pipe? Yes ___ No ____ If YES,
   a. For water: service lines, distribution or transmission Maybe
   b. For wastewater: laterals, gravity or force mains. Maybe
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) Maybe
   d. Storm Drains Yes (most common application)
   e. Other Services: (Casing, Roadway Drain)

   f. Are there any limits or restrictions to its use in the system? Yes ___ No ___

   g. Does the utility allow PVC as an alternate or equal? Yes ____ No ____
      What services is it allowed?

2. Is there a standard specification or guideline for use? Yes ___ No ___
   a. When (about) was it approved for use? Storm drains (ongoing),
      20" sewer force main slip line inside 24" ACP back in 2002 and 24" HDPE
      pipe burst with existing 16" RCP gravity sewer back in 2004
   b. Why was it approved for use in the system? Recommended by
      design/consultant engineer or cost savings due to trenchless (slipline or
      pipe burst).

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes ___ No ____ Describe: Limited training for repair
   and fusing but District staff never purchased fusing equipment nor obtained
   certifications.

4. When allowed was there an impact to operations and maintenance for repairs,
   inventory of parts and equipment? Yes ___ No ____
   a. Describe impacts: Experienced issues with couplings/tees. Difficult to
      find parts/coupling adapters resulting in lengthy shutdown and nuisance,
      Also difficult to find third party contractor qualified to repair HDPE at a
      moments notice.
   b. Has the cost effectiveness been evaluated? Yes ____ No ____
c. How often is it used or bid as an option? Rarely __for sewer/water__  
   Regularly __for small storm drain__

d. What is your opinion of HDPE?

☐ Satisfactory  ☐ Neutral  ☐ Unsatisfactory  

Comments: _______ In my opinion corrugated HDPE storm drain pipe is a good option but don’t recommend using HDPE for water/sewer due to difficulties with repair. ________________________________
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Salt Lake City Public Utilities

Contact Person: Jason Brown Position Title: Development Engr.

E-mail: Phone #: 

1. Does the utility allow HDPE pipe? Yes ___X__ No _____ If YES, 
   a. For water: service lines, distribution or transmission ___NO___
   b. For wastewater: laterals, gravity or force mains. ___Force mains___
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) ___YES___
   d. Storm Drains ___Ribbed___
   e. Other Services: (Casing, Roadway Drain) 

f. Are there any limits or restrictions to its use in the system? Yes __ No ___

   g. Does the utility allow PVC as an alternate or equal? Yes ___X__ No _____

   What services is it allowed? ___ALL___

2. Is there a standard specification or guideline for use? Yes ____ No ___X___
   a. When (about) was it approved for use? 
   b. Why was it approved for use in the system? 

3. Has training been provided to city maintenance, inspectors, engineering or others 
   for working with HDPE? Yes ___ No ___X___ Describe: 

4. When allowed was there an impact to operations and maintenance for repairs, 
   inventory of parts and equipment? Yes _____ No _____

   a. Describe impacts: 

   b. Has the cost effectiveness been evaluated? Yes ____ No _____

   c. How often is it used or bid as an option? Rarely ___ Regularly ___

   d. What is your opinion of HDPE?

   [ ] Satisfactory [ ] Neutral [ ] Unsatisfactory

   Comments: 


CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: City of Toronto
Contact Person: Cliff Chu Position Title: Manager
E-mail: cchu@toronto.ca Phone #: 416-392-8252

1. Does the utility allow HDPE pipe? Yes _X_ No ____ If YES,
a. For water: service lines, distribution or transmission _______ Transmission
b. For wastewater: laterals, gravity or force mains. ______ Forcemains
c. Trenchless Installations. ( HDD crossings, Pipe Bursting, Lining) ______
   We had used PE pipe for trenchless installations
d. Storm Drains _______ N/A
e. Other Services: (Casing, Roadway Drain) _______ N/A
f. Are there any limits or restrictions to its use in the system? Yes _X_ No
   May not be appropriate for water mains with lots of service connections
g. Does the utility allow PVC as an alternate or equal? Yes _ No ____
   What services is it allowed? _____________________________

2. Is there a standard specification or guideline for use? Yes _X_ No ____
a. When (about) was it approved for use? ______ MOE already approved
b. Why was it approved for use in the system? _____________________________

3. Has training been provided to city maintenance, inspectors, engineering or others for working with HDPE? Yes _X_ No ____ Describe: only apply to engineers

4. When allowed was there an impact to operations and maintenance for repairs, inventory of parts and equipment? Yes _X_ No ______
a. Describe impacts: ______ special parts have to be ordered
b. Has the cost effectiveness been evaluated? Yes _X_ No _____
c. How often is it used or bid as an option? Rarely _X_ Regularly ______
d. What is your opinion of HDPE?

☐ Satisfactory ☐ Neutral ☐ Unsatisfactory
Comments: ______ My comments only apply to the trunk facilities.__________
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Pueblo Board of Water Works

Contact Person: Terry Book Position Title: Deputy Executive Director
E-mail: tbook@pueblowater.org Phone #: 719.584.0233

1. Does the utility allow HDPE pipe? Yes ___ No ___ If YES,
   a. For water: service lines, distribution or transmission
   b. For wastewater: laterals, gravity or force mains
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) ___
      River Crossing, Special applications where jointed pipe is not practical
   d. Storm Drains
   e. Other Services: (Casing, Roadway Drain)

f. Are there any limits or restrictions to its use in the system? Yes X No ___ We have not used it in applications where we would have individual service line taps

g. Does the utility allow PVC as an alternate or equal? Yes ___ No X___
   What services is it allowed? We recently have considered fusible PVC as an alternate but have not constructed a project with fusible PVC

2. Is there a standard specification or guideline for use? Yes ___ No ___
   a. When (about) was it approved for use? 2000
   b. Why was it approved for use in the system? Specific river crossing application utilizing directional bore

3. Has training been provided to city maintenance, inspectors, engineering or others for working with HDPE? Yes ___ No ___ Describe: Limited by supplier

4. When allowed was there an impact to operations and maintenance for repairs, inventory of parts and equipment? Yes ___ No X ___
   a. Describe impacts: No repairs to date
   b. Has the cost effectiveness been evaluated? Yes ___ No X ___
   c. How often is it used or bid as an option? Rarely ___ Regularly X ___
   d. What is your opinion of HDPE?
      [ ] Satisfactory [ ] Neutral [ ] Unsatisfactory
Comments: Our applications have been limited to special projects so I don't have an opinion on routine use in a distribution system application.
Meador, Kevin J.

From: Holly Link [hlink@csu.org]
Sent: Tuesday, August 21, 2012 2:16 PM
To: Meador, Kevin J.
Cc: Tara McGowan; Ronald Sanchez
Subject: FW: HDPE Pipe Survey
Attachments: HDPE Questions Aug 2012 CSU.pdf

Kevin,

Here are answers to your questionnaire. I write the Standards and Specifications for the Water, Wastewater and Non-potable systems. I could go on and on about HDPE as we have used it a lot and mostly in 8” to 24” DR9 pipe. We have learned a lot of lessons along the way in placement of HDPE pipe and fittings. If you need more information than this then please contact me. I did not want to overwhelm you with information that you may not need.

Holly

Holly L. Link
Colorado Springs Utilities
Engineering Support Specialist Sr.
WSD/PERM/PEW/Water-Wastewater Engineering Standards
1521 Hancock Expy, MC1821
Colo. Spgs., CO 80947
Hlink@csu.org Office: 719-668-4733 Cell: 719-661-3389 Fax: 719-668-2677

From: Ronald Sanchez
Sent: Tuesday, August 21, 2012 12:33 PM
To: Holly Link
Cc: Tara McGowan
Subject: FW: HDPE Pipe Survey

Holly,

Could you follow up with this survey? You know more about why we use what we use.

From: Rick Sanchez
Sent: Tuesday, August 07, 2012 6:48 AM
To: Ronald Sanchez
Subject: FW: HDPE Pipe Survey

From: Meador, Kevin J. [MeadorKJ@bv.com]
Sent: Monday, August 06, 2012 3:37 PM
To: Meador, Kevin J.
Subject: HDPE Pipe Survey
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Colorado Springs Utilities (CSU)

Contact Person: Holly Link

Position Title: Engineering Support Specialist Sr.

E-mail: hlink@csu.org Phone #: 719-688-4733

1. Does the utility allow HDPE pipe? Yes X No ____ If YES,
   a. For water: service lines, distribution or transmission ALL
   b. For wastewater: laterals, gravity or force mains. ALL
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) ALL
   d. Storm Drains Not CSU Responsibility
   e. Other Services: (Casing, Roadway Drain) Possibly for Casing, Researching that now
   f. Are there any limits or restrictions to its use in the system? Yes X No

2. Does the utility allow PVC as an alternate or equal? Yes X No ____ What services is it allowed? Water and Wastewater, no fusible PVC

3. Is there a standard specification or guideline for use? Yes X No ____
   a. When (about) was it approved for use? 2004
   b. Why was it approved for use in the system? We needed a more flexible pipe that would not corrode and would work in high pressure and land slide areas.

4. Has training been provided to city maintenance, inspectors, engineering or others for working with HDPE? Yes X No ____ Describe: CSU construction employees need to acquire HDPE Certification, Engineers have been to HDPE Engineering Seminars

5. When allowed was there an impact to operations and maintenance for repairs, inventory of parts and equipment? Yes X No ____
   a. Describe impacts: Lead time to get parts and we designed our own parts for ease of placement in the field
   b. Has the cost effectiveness been evaluated? Yes X No ____
   c. How often is it used or bid as an option? Rarely ___ Regularly ___
d. What is your opinion of HDPE?

☐ Satisfactory  ☐ Neutral  ☐ Unsatisfactory

Comments: We have had our learning curve with HDPE we use DR9 PE 4710 in our Water Distribution system and DR 17 in our wastewater system. Water service is also DR9. We have had a lot of challenges that we have overcome in learning to place HDPE in our systems.
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: __MWRD___________________________

Contact Person: ___Dan Brown_________ Position Title: __O&M Engineer____
E-mail: ____________dbrown@mwrд.dst.co.us_________ Phone #: _303-286-3216____

1. Does the utility allow HDPE pipe? Yes _____ No __X__ If YES,
   a. For water: service lines, distribution or transmission ________________
   b. For wastewater: laterals, gravity or force mains. _________________
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) _____________
   d. Storm Drains _________________________________________
   e. Other Services: (Casing, Roadway Drain) ___________________________
   f. Are there any limits or restrictions to its use in the system? Yes __ No__
      ____________________________
   g. Does the utility allow PVC as an alternate or equal? Yes ____ No ____
       What services is it allowed? _______________________________________

2. Is there a standard specification or guideline for use? Yes ____ No __X__
   a. When (about) was it approved for use? ____________________________
   b. Why was it approved for use in the system? __________________________

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes ____ No __X__ Describe: ________________

4. When allowed was there an impact to operations and maintenance for repairs,
   inventory of parts and equipment? Yes _____ No ______
   a. Describe impacts: _____________________________________________
   b. Has the cost effectiveness been evaluated? Yes ____ No ______
   c. How often is it used or bid as an option? Rarely __X__ Regularly ____
   d. What is your opinion

☐ of HDPE? ☐ Satisfactory    ☐ Neutral    ☐ Unsatisfactory

Comments: HDPE is sensitive to installation procedures & proper
placement of bedding & backfill, & areas with high groundwater.
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Greeley

Contact Person: Curt Knight Position Title: Chief Engineer

E-mail: Phone #: 

1. Does the utility allow HDPE pipe? Yes _____ No ___ If YES, Delamination issue 10 yrs ago.
   a. For water: service lines, distribution or transmission ______
   b. For wastewater: laterals, gravity or force mains. ______
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) ______
   d. Storm Drains ______
   e. Other Services: (Casing, Roadway Drain) ______
   f. Are there any limits or restrictions to its use in the system? Yes ___ No ___
   g. Does the utility allow PVC as an alternate or equal? Yes ___ No ___
      What services is it allowed? Water, Sewer, Stormwater ______

2. Is there a standard specification or guideline for use? Yes ___ No ___
   a. When (about) was it approved for use? ______
   b. Why was it approved for use in the system? ______

3. Has training been provided to city maintenance, inspectors, engineering or others for working with HDPE? Yes ___ No ___ Describe:

4. When allowed was there an impact to operations and maintenance for repairs, inventory of parts and equipment? Yes ___ No ___
   a. Describe impacts: ______
   b. Has the cost effectiveness been evaluated? Yes ___ No ___
   c. How often is it used or bid as an option? Rarely ___ Regularly ___
   d. What is your opinion of HDPE?
   e. Satisfactory  Neutral  Unsatisfactory
         Comments: ______

Use of HDPE discussions from DSS Conference attendees September 10th and 11th, 2012 in St. Louis

City of St. Louis Water Division, Mark McLaughlin, Supervisor Water Distribution, 314-633-9036

- Used for transmission mains in 2 specific locations because of special conditions, 1 was over 1,000 feet in downtown over a tunnel and corrosive conditions.
- Typically used for trenchless installations

Wilmington, DE, Colleen Arnold, Director of Water

- Use for trenchless applications or specific application crossing wetlands or similar conditions,
- Not in standard specification

New Orleans Water Board, Steven Bass

- Used for force mains or trenchless application
- Not aware of any used in water system

Des Moines, IA, Dan Klopfen, Infrastructure Planning Mgr., 515-283-8754

- Allowed in standard specification used with approval, but typically not used or approved

Cedar Rapids, IA – not allowed except for special conditions (trenchless)

Wichita, KS, Elizabeth Owens, Water Distribution Supt., 316-219-8920

- Not aware of any used in the system, did not know if in standard specifications

Howard County, MD, Susan Donnelly (O’Brien & Gere)

- First HDPE transmission main open cut project is currently out for bid

Indiana American Water, Jacquelyn Sanders, Operations Supt.

- Not approved for transmission or distribution but has some in the system, maintenance have complained about connections and taps pulling out
- Used for trenchless installations, (river crossings) they require ductile iron pipe size so if they are connecting to a 12" DIP they require 14" HDPE

Shoreline Water District (Near Seattle, WA), Michael Oberstadt, 206-362-8100

- Not used in water system but some has recently been used in gravity sewer (George 206-546-2494)

San Jose Water Company, Jacob Walsh

- Not in standards, but used once for a trenchless crossing
LCWSA (Lycoming County PA), Tom Holmes, Field Supervisor, 570-546-8005

- Used only for specific projects, trenchless, in wetlands or corrosive soils

Lawrenceville, GA – not used at all

Springfield, IL, Kirk Eberding, Supt Operations, 217-789-2323

- Used for service lines but are in the process of changing to different material (polypropylene) because of problems. HDPE has a strong coil memory and was difficult to install and would snap at connection.

City of Atlanta, Tim Sullivan, CMIS Manager, 404-235-2002

- Used for trenchless installation only, likes the material but not used in the system

Pearland, TX, Connie Bondar – Not used at all
APPENDIX B

CONTACT REPORTS
Subject: I called with questions regarding their recent experience using HDPE water service lines.

1) Do you still allow all the types and manufacturers of HDPE pipe as listed on p. 28 of your Ch. 7 Water Service Installations Specification (2010)? Yes- Developers requested and they opened up the specs. to allow. Property owner owns only from curb stop to house, City owns from the curb stop to the main. Others that have been added? They allow only the 4710 resin material now.

2) Have you considered allowing the newer 'composite' aluminum core type? Holly Link's answer: We did look at this pipe, however it has not been approved, there are concerns over the coating (what happens if it is scratched and aluminum exposed or water exposure internally to the aluminum) and that it could easily kink.

3) Do you now require the new HDPE material std. under ASTM D2737-12a? 4710 - yes

4) I don't see an NSF stamp or approval requirement in your specs. Is that required? YES, all must be stamped.

5) Is it mostly 1 inch size HDPE now being installed? YES Only 2 inch max. size HDPE allowed. And/or how much copper is still being installed (rough estimate) percentage wise? YES, still mostly for 2 inch. Meter loops require a transition from copper to HDPE - transitions critical - some flooded basements have occurred. Outside meter pits - flexibility of HDPE vs. Copper- needs additional supports - Buried couplings allowed? Difficult to not allow because otherwise welding is needed which contractors are not set up to do (to do repairs). They do not allow HDPE to come into vaults---Transition has to occur outside the vault, with D.I. or PVC.
6) Are there instances where you still require copper under some roadways up to the curb stop, and then hdpe from there to the meter? 

**CO Springs maintains to the curb stop. Rest is the Owner’s responsibility to repair and maintain.**

If so, what are your reasons for that? **Util Maint. guys still like to use copper in the street ROW. Compression couplings repairs sometime allowed. Concerns with pull out however remain.**

Does the property owner own the line to the main or just to the curb stop? **Just to the curb stop.**

7) Do you see a difference between the blue vs. black plastic HDPE materials? **Holly-- The blue is softer than the black and even though it claims to be the same material, it has a different feel. I have not had any reports that the Performance is any different.**

8) Does the factory install the stiffeners or the installers? **We or the Contractor installing the Service Line place the stiffeners where they are needed into any mechanical fitting including couplings. No one knows where the fittings will fall and the length of the line prior to placement as the HDPE Service line comes in a roll.**

9) Have there been instances of failures or leaks in the few short years that you have been allowing the newer hdpe tubing materials? **At the Fittings- YES. Proper Install and restraints are critical and has not always been done. They no longer allow hdpe in meter pits, only copper- so they are updating details to show this.**

10) Are you warranting the use of the service lines to the adjoining property owners, and if not, do you recommend any sort of insurance? **Expect to have some Bumps and bruises along the way- a learning curve is required - No one wants to be the ‘guinea pig’. Ultimately It is the home owners responsibility if there are problems. No insurance provided or recommended by the City. Plumbers have not installed or followed guidelines where there have been failures.**

I asked her also about their willingness to share what they have learned, and if any compensation for that would be requested. **She said they are more than willing to have some of RC people come down and they would show and tell their experiences. Or a webinar of sorts could be set up. They are re-doing standards and details again this year, and will publish in 2014. They will be glad to share what they are learning. Also the PPI representative is willing to show up and talk about the material, and we could put a call into him. She said they have also hired a pipe ‘expert’ from Canada to help in re-writing their standards, because they needed somebody with some real world experience in specifying and using this material.**

**She said it is not really economical compared to other materials as far as general distribution and water main use, even though their specs. now do allow it. She said also a major concern is that engineer’s really don’t know how to design or specify around it- and she urged a case by case evaluation before it is designed in to a project. It’s great for unstable soil or hillside areas and directional drilling applications but beyond that she indicated that widespread acceptance and use was not likely.**

Notes taken by D.LaFrance  April 2, 2013
CURRENT MUNICIPAL USE OF HDPE PIPE

Name of Utility: Denver, Colorado

Contact Person: Wayne Query Position Title: Wastewater Engineer

E-mail: Wayne.Query@denvergov.org Phone #: 303-446-3641

1. Does the utility allow HDPE pipe? Yes X No ____ If YES,
   a. For water: service lines, distribution or transmission _____ No __________
   b. For wastewater: laterals, gravity or force mains. _____ No __________
   c. Trenchless Installations. (HDD crossings, Pipe Bursting, Lining) _____
      Pipe Bursting Only at this time for sanitary sewer only
   d. Storm Drains _____ No __________
   e. Other Services: (Casing, Roadway Drain) _____ No __________

f. Are there any limits or restrictions to its use in the system? Yes X No __
   do not allow where many laterals need to be cut in

g. Does the utility allow PVC as an alternate or equal? Yes X No _____
   What services is it allowed? _____ Fusible PVC for pipe bursting

2. Is there a standard specification or guideline for use? Yes X No _____
   a. When (about) was it approved for use? _____ Only SDR 17 used
   b. Why was it approved for use in the system? _____ Flexible, tough
      Use for sizes 8 to 12 inch normally, one time up to 30 inch

3. Has training been provided to city maintenance, inspectors, engineering or others
   for working with HDPE? Yes X No _____ Describe: _____ Special fittings

4. When allowed was there an impact to operations and maintenance for repairs,
   inventory of parts and equipment? Yes X No _____
   a. Describe impacts: _____ special fittings and tools
   b. Has the cost effectiveness been evaluated? Yes X No _____
   c. How often is it used or bid as an option? Rarely X Regularly _____
   d. What is your opinion of HDPE?

   x Satisfactory □ Neutral □ Unsatisfactory

   Comments: JavaScript detected
   Do not use fold and form methods for installation, bad experience
   HDPE combined with upsizing using 'reaming' method also has worked well for them.
Contact Report

Date:       Wednesday - 10/10/2012
Contact:    Colorado Springs Utilities
Tel/Fax:    719-668-4733
Email:      hlink@csu.org
Address:    Colorado Springs, CO
Subject:    HDPE Experience
Project:    City of Rapid City HDPE Investigation
            BAI. No. 21519.00.01

Holly Link in Colorado Springs was gracious enough to stay on the line with me for an hour and a half- and you can see some of the highlights from that discussion with her below. I started out by saying I really wanted to get at the Learning Curve aspect of what it takes to work with this material as a primary goal of the questions I was going to ask her. Sig and I felt that it was important to try and glean more from the experience that this particular system has had, both the Pro and the Con.

In summary, she would be quick to say that they are still ‘learning’ after almost 13 years of ‘trials’ - but that she believes the material has some strong points for very specific applications. Not including one large diameter Sanitary force main, she would estimate that they have less than 10 miles of HDPE smaller diameter pipe for water (12, 10 and 8 inch) that has been put in. In over 12 years, that is not a large percentage for their system she said. The City crews have a handle on the material now she says- Contractor installed work is a different thing she says- and the ‘learning’ curve continues.

1) When did you start using? Year 2000 started experimenting with. Due to high corrosive potential primarily. Secondarily for landslide prone areas.

2) Which application was first? Water in the beginning mostly. 8 inch was the first one they installed (City crews), water with service saddles (pipe moved) and spring washers did not hold- everything moved. Then went to try electrofusion to repair the initial connections, and that did not work. So they have not tried again-. Electrofusion, that is. Poly cam side wall fusion, fuses onto the pipe is what they turned to. Has a brass fitting right in the corp. stop. Special sidewall fusion machine required. This is all they will allow now. The corp stop (brass) is embedded right into the side wall fusion kit, and then the service line can be tapped in at that point as is typical.

For DR9- they originally jerry- rigged the tapping machines to get through the extra thickness for the service lines. They now have different bits and specialty tapping equipment just for HDPE when they need to use it. City crews primarily are the ones who put on the Poly cam side wall fittings (has to be air tested, to make
Contact Report (cont’d)

sure weld is good, for 1 and 2 inch tap sizes). Contractors can do in some cases, with City inspectors witnessing. They require pipe cutting and fusing in a POLY tee for any laterals for anything 6 inch or larger. Min. 1 inch PE service lines (matches with ⅜ inch tube size), and 2 inch (and Copper is also still allowed and used). They do not allow mechanical saddles for taps. Ownership?: From the curb stop the homeowner owns the service pipe to the house, City owns from the curb to the main. She did not mention any specific problems or differences of using Poly service lines vs. copper.

3) Did you open it up gradually or all at once for both water and wastewater usage? Wastewater FM force mains only has been tried (with one exception of a profiled wall pipe trial). Quite a few Miles long - either 20 or 24 inch, could not remember for sure. In the ground since 2002 and no problems. I asked about Air Vacs and attachments. She did not have any specific info. on any problems or if their were Air Vacs. On the line - Water lines is mostly where they were having the (premature failures and breakage) problems, so in 2000 is when they started trying HDPE to find a better material to use- due to the problems that neither PVC or DI were able to solve.

Side note:
Deheading is not easy to do- but can and should be done if considering for gravity sewer lines, she said.

4) Are you now exclusively allowing HDPE, or is PVC or DI still allowed? Primarily PVC main part of town- moving away from Ductile Iron. They require the heavier ASTM C 110 rings for MJ fittings (problems with C153 breakage). For cathodic protection, the go with All 8 mil fusion bonded epoxy fittings-- then primered and wax taped, and sealed with plastic.

Min. 2 year warranty - required. For all their installations.

5) Did you open up your general specs. to HDPE, and if so when? They have opened and allowed HDPE for water main usage in General Specs. since 2009. Developers/Engineers can choose which materials to use for their development, City can advise if HDPE might be a better fit where needed (per above). HDPE is now allowed for water distribution under General Conditions, but you must have certified and trained people for installation. I asked her how much of the time is HDPE now being used compared with PVC or other. 95% designed and installed is still PVC, material of choice by developers, even though the spec. is now open to HDPE for several years. For D.I. Pipe use, they have moved almost completely away from allowing that due to corrosion issues.

6) Special Considerations?
Wall anchors, it depends where to put them- She recommends being conservative based on lots of leaks at fittings and valves and connections, for one reason or another. Wall anchors are your protection. More are better than fewer.

* If boring- will need one on each end, before fitting connections to dis-similar pipes or valves.

Page 2 of 5

Brookings, SD | Sioux Falls, SD | Vermillion, SD | Rapid City, SD | Pipestone, MN | St. Peter, MN
Contact Report (cont’d)

* Within 10 ft. of each side of a tee- Need to let the ‘whole pipe’ relax- before attaching- See PPI TN #38 Guide- Tightening and Torquing requirements
* Within 10 ft. of tie ins to existing
  Use HDPE MJ adapters coming into valves- problems with install on BFV valves, beveled MJ required. - difficult to find a beveled MJ for DR 9, she said.
  They have 4 Mfgrs. that are approved for MJ fittings: Secor, Isco, IPF, IPP

Does your water temperature fluctuate that much?
Water Temp. fluctuations are minimal- therefore once buried, the pipeline itself should be fine. No problems with pipe, just fittings.

They had a leak occur once at an HDPE cross (8 x 8) - and it was a stress fracture in the fitting itself- due to weight loads (due to Pre-Assembly of an HDPE valve cluster) and possible lack of proper harnessing, and supports during installation they think.

Case by Case approvals? Can you explain that a little bit more? Only Util. crews allowed to install HDPE, only Mech. Fittings in the beginning- then with more fittings, they started fusing more and using MJ fittings. Some issues with valves, and that is better now with more options from manufacturers. Lots of pull outs before.

Pressure vs. Gravity differences, other than pressure class and Pipe DR? What are your normal op. pressures on your system, or range? Min. 200 psi (250 preferred) or DR 9 pipe for water only allowed. VERY IMPORTANT to stay with heavier pipe for these issues- Hill sides and corrosion, ground movement.
  Bedding
  Buoyancy
  Linear Expansion- or fitting pull out issues, at laterals or manholes? Not used for sewers, per before. Need to address all the detailed installation issues she said, or their will be problems.

Make sure on fittings- ‘pups’ or solid sleeves, make sure there is ‘support’ for those- if not adequate support, can be a problem because HDPE ‘bows’.
  Most all failures are at the fittings, they never use HDPE 90s bends at their pressures, only 22.5 or 45 HDPE, and use sparingly but o.k. to use, based on their experience.

They do specify and allow 4710 resin only now due to their higher system operating pressures and fluctuations. They Don’t allow 3408 anymore. Still some fittings that are the old resin. She said they will fuse together, but you need to start heating one material before the other because one takes more time to heat up than the other.
Contact Report (cont’d)

The City requires a Data Logger (for welding quality control, and record purposes) - but most times Contractors don’t show up with that she said.

How to handle laterals and branch lines- Mech. Fittings, or electrofusion? See above discussion.

Storm Pipe? Different Dept? - Profiled Wall Pipe- They did a Test on a sewer line recently- and did not go well she said. Did not have the details, but said apparently bedding was too difficult for Contractor, or some other type excuse. 
The City has begun to use some storm pipe- profiled wall, she said, on a limited basis. 
Pueblo had a bad experience with pipe- not installed correctly. Failure of bedding, ? She said- articles came out on this

Would you do it differently for some applications in hind sight- given the learning curve?

Contractor’s must show Experience before being allowed to use HDPE- (any Contractor, before will approve). Certifications, training, experience- it all comes down to that she said. And still very few have that she said. For City Operations, they had to be the ones to jump in first and get all the training and certifications for their own people, and get the proper tools, equipment and parts, before they could know and experience first hand what they were going to be getting into. It took a lot of trial and error, but they now feel like they have a pretty good handle on the use of the material and the right way to get it installed- and she says they still believe it is a good material, for special applications and areas where you really need it. They had unique motivators for changing at the time, and they stuck with it to make it work. Now it does for the most part, with very few problems.

Make the factory add a piece (pups the called them) to each of the fittings that they need for handling and fitting up into the fusion machines in the field, or you will have problems fusing the fittings together. Needs to fit within 2 to 3 jaws, otherwise fusion will not be good (need to have a min. of at least 2 clamps, to hold in place and align). They now own 2 of their own fusion machines (6 to 12 inch sizes). They rent for larger size pipes installations. Pup size lengths put together by Co-worker Peter Bond (now retired).

Their new policy requires them to look at both the cost of the pipe, and the time to install (allowing time for cooling, for each joint before moving, etc.- ) Const. time and $$$ will increase due to these factors, vs. installation costs associated with standard PVC pipe. USE of HDPE typically has to be justified before it will be approved for new CIP (water) projects.

Disinfection of the pipe- weld joints must be debeaded (at the factory) on the inside before they come- little curls catch dirt and contaminates.
Contact Report (cont’d)

Need longer time to chlorinate and disinfect if not. Must CAP at night— they have had issues. The beads have caused disinfection times, and successful passing of Bac-Ts to be longer to pass, than with PVC in general she said.

Review of Plans— look at the connection points. MOST CRITICAL item to look for and stay on top of. She said their own engineers don’t always know what details still to look for when approving plans for development work using HDPE.

Temperature Experiences— less than 32 degrees (use tenting) per PPI recommendations. If snowing or freezing, the city doesn’t allow fusing to go on.

Bags of ice on the pipe, and tent over the valve. This has happened on some hot days that she has seen, when the pipe was actually expanding too much and the Contractor could not fit it into its correct tie in points. Cut length errors can be expensive, if someone cuts a pipe when it is too cold or too hot. Need pipe to contract, or expand, and wait until the pipe says it’s ready for the valve or fitting to go in.

Explain a little more for me some of the challenges that you have had to overcome.

Had a lot of push back from the crews originally— Another sup’r. was brought in to move away from metal (ductile iron?)— and needed to handle the higher pressures, and better deal with corrosivity. They had (2) high level champions (City Manager, and Sup’t.) to make the move to HDPE originally she said— Some current Project Manager’s have not had the best experience lately with HDPE, so are still wary of allowing the use of the material, if optioned by a Developer/Contractor (still don’t know how to get it right in many cases). The learning curve is still very broad and ongoing.

Prepared By: David LaFrance, PE
Contact Report

Date: Friday - 10/12/2012
Contact: Holly Link - Colorado Springs Utilities
Tel/Fax: 719-668-4733
Email: hlink@csu.org
Address: Colorado Springs, CO
Subject: HDPE Experience- Follow Up Questions
Project: City of Rapid City HDPE Investigation
BAI. No. 21519.00.01

Just a minor additional question, as I see you do require the stainless steel stiffeners for the MJ adaptors, and OD compression mechanical couplings.

The Stiffener in the MJ Adaptors is put in by the manufacturer and is a part of the fitting. Because of our pressures we require that piece in the fitting. It is a metal band 1-2" wide depending on size that is pressed in to the inside of the MJ.

Are these a solid sleeve or split sleeve type?

Our Stiffeners are the split or wedge type and our contractors have the option to choose which one to use, we had better luck with the split with the straight insert than the wedge part.

I have seen both mentioned in a couple articles. The reason I ask is because I saw on my project where the ID on each end of the pipe segment (the last 18 inches or so), is not the same ID as the balance of the piece. I found that it was a smaller diameter by up to a quarter to half inch. When I asked why, I was told that is called the ‘beveled ends’ which happens when they hold the uniform OD as they are producing the pipe, but when they do the cut off at the factory it pinches off and necks down the ID near the ends where the cut is made. Just curious if you have seen or experienced that as well, and if so, is that where you would require or call for a split SS steel sleeve, vs. a solid one because you would need that to be adjustable for the field installation to fit? Yes we have run into this issue. Because of this when we require a stiffener by using the straight slot our crews at times may need to cut anywhere from 1/2 inch to an inch out of the stiffener to be able to put the expansion slide in and get a tight fit. Another reason to use the straight slot instead of the wedge stiffener.

For your ‘wall’ anchors- are those done with a fused attachment of some type to the outside wall of the pipe, or do you use a mechanical coupling of some type that somehow ‘bites’ sufficiently into the pipe to hold it? We always butt fuse these to the pipe. If mechanical type, do you require or see a need for a ‘stiffener’ at that point on the inside of the pipe? Yes, anytime you are using a mechanical fitting you must have a stiffener.
Contact Report (cont'd)

Prepared By: David LaFrance, PE
Contact Report

Date: Wednesday - 10/03/12
Contact: Rusty - Rapid Valley Sanitary District
Tel/Fax: 605-393-1050
Email:
Address:
Subject: HDPE Service Lines
Project: HDPE Evaluation for City of Rapid City
BAI. No. 21519.00.00

I contacted Rusty to see what RVSD policy was regarding service lines. He stated they allow copper or 200 psi copper-OD HDPE service lines. I asked how long they have been allowing HDPE service lines – he stated approximately a year.

Rusty stated he now prefers HDPE for service lines – it is considerably less costly and thinks he will have few problems going forward. Rusty stated copper tubing they are now getting is typically somewhat flattened in the coil (oval-ed) and it is difficult to round to get on the fitting. Also contractors may dimple the copper tubing during installation, and if they don’t properly get it out, the turbulence at the dimple erodes the tubing and likely will leak down the road.

Rusty stated he thinks the HDPE is easier to handle (didn’t see an issue even in cold temps), and all the fittings are the same as copper – just need to insert interior steel stiffener in HDPE at connections.

Rusty also like the fact that HDPE will be easier to replace, if needed, without disturbing as much street. Can pothole at the corp and at the property, then run a cable thru, pull back a splitter followed by “Chinese finger” to pull new service line. Same procedure isn’t as successful with copper since copper doesn’t split as easy and instead balls-up which can make pulling difficult, if not impossible. Rusty stated he has broken Chinese fingers before trying this with copper. Rusty stated using a bigger splitter with HDPE facilitates this process better for pulling a bigger line back in.

To date, haven’t had problems with HDPE and believes they will be less likely to leak than copper (corrosion, dimple or kink leading to leak). Currently not using HDPE for other applications.

Prepared By: Sig Zvejnieks
Contact Report

Date: Monday - 8/13/12
Contact: Mark Mayer – SD DENR
Tel/Fax: 605-773-0
Email:
Address:
Subject: HDPE Water Lines
Project: HDPE Evaluation for City of Rapid City
BAI. No. 21519.00.00

I contacted Mark to see what the State is seeing as far as HDPE utility lines on plans submitted to & approved by them. Mark stated they see a lot on service lines, but usually as an alternate material and not exclusively called out for HDPE.

I asked about uses in water transmission or water distribution mains. Mark stated the only times they have seen HDPE is on trenchless applications where the pipe is bored and pulled into place. Wall did that in selected locations where they didn’t want to open-cut the street and/or disrupt traffic. Mark stated Wall did have problems where the HDPE “relaxed” after installation and pulled out of fittings.

Mark stated he was aware the USACE installed HDPE in the Mni Waste’ intake — I told him I was aware of the 14 miles of 14” pipe that was weighed and sunk along the Cheyenne River tributary to Oahe between the new and old intakes. They have had considerable problems at the connections in the intake & submersible pumps.

Mark stated they have seen any HDPE open-cut installation submitted — he thought that HDPE would be good in applications where encroachment or getting adequate separation from sewer or septic is problematic — with the butt-fused pipe, wouldn’t have joints to worry about potential contamination.

Mark flagged the concern with using HDPE in locations with hydrocarbons — HDPE is permeable and not acceptable where that can be an issue. He cited Delvin DeBoer’s study that shows HDPE is significantly more permeable than PVC.

I asked about gravity sewer applications — Mark stated he is not aware of approved HDPE gravity sewer lines — stated he deals mainly with water lines and referred me to others in SDDENR (Kent Woodmansey, Mark McIntrye) that could possibly provide more information in that vane.

Prepared By: Sig Zvejnieks
Contact Report

Date: Thursday - 08/16/2012
Contact: Chip Petrik
Tel/Fax: 605-394-4163
Email: 
Subject: HDPE Service Lines
Project: City of Rapid City HDPE Investigation
BAI. No. 21519.00.01

I met with Chip to discuss what concerns from a maintenance side he would have over allowing the use of HDPE service lines. Chip and I discussed at length some of the concerns that he would have.

1. The gooseneck type connection. One of the issues that the City had with Poly B service lines was the gooseneck connection, a lot of instances of failure was at the gooseneck from movement, copper provides stability to the fitting, and poly b didn’t.
2. Tracing of the line. The City is responsible for tracing, with one-calls. I suggested using a tracer wire.

We also discussed the positives and negatives for using the material as a service line. A few negatives that the industry users have noted are contaminated soils, and thawing of the line after freezing.

Prepared By: Keith A. Winter
Contact Report

Date: Thursday - 08/13/2012
Contact: Covington Water Department – Brian Borgstadt
Tel/Fax: 253-531-0565
Email:
Address: 18361 SE 300th Place
          Covington, WA 98042
Subject: HDPE Service Lines
Project: City of Rapid City HDPE Investigation
         BAI. No. 21519.00.01

At 2:35 pm, Brian Borgstadt from Covington Water District called me to discuss their use of HDPE service lines. I told him that the City of Rapid City is considering opening their specifications to allow the use of HDPE service lines, but we had a few quick questions to look at. I asked them 6 questions:

1. Do you allow the use of PEX, and Hot Core as well as HDPE?
   a. They have 4 approved products in their specifications:
      i. Interstate Plastics (Super Service Blue HDPE 3408)
      ii. JM Eagle (Pure-Core)
      iii. PolyPipe, Inc. (PolyStripe)
      iv. Superlon (SuperTuff)

2. How long have you been using HDPE in the City?
   a. About 3 years

3. Have you had any problems with material performance over years (breakage, degrading, etc.)
   a. Easier to work with and less issues than copper. Field Crew likes it because they underground bore through existing copper. Only downside hard to trace unless you require tracer, if you listen for leaks, copper traces faster – hard to trace out, if there are petroleum leaks – gasoline can seep into ground under driveways and get into the pipe, have to be careful with contaminated soils.

4. Have you had any Contractor issues with materials?
   a. Contractors are happier it is easier to work with than copper.

5. Why did you guys make the switch to HDPE?
   a. Brian was always skeptical, but it was the maintenance crew that drove it, on the development side of the meter, PE pipe allowed, as the Engineer he wants the district to uphold to the same set of rules as developers, plus it is 1/5 the price.

6. Are the service lines owned by the Utility or the property owner?
   a. Yes to the meter.

Prepared By: Keith A. Winter
Contact Report

Date: Wednesday - 08/08/2012
Contact: Lynn Arakaki – Senior Engineer with the City of Redmond
Tel/Fax: 425-556-2841
Email: LARAKAKI@REDMOND.GOV
Address: Redmond Washington
Subject: HDPE Service Lines
Project: City of Rapid City HDPE Investigation
BAI. No. 21519.00.01

At 10:32 am, Lynn Arakaki from the City of Redmond, Washington called me to discuss their use of HDPE service lines. I told her that the City of Rapid City is considering opening their specifications to allow the use of HDPE service lines, but we had a few quick questions to look at. I asked her 5 questions:

1. Do you allow the use of PEX, and Hot Core as well as HDPE?
   a. No, we only allow HDPE pipe.
2. How long have you been using HDPE in the City?
   a. 25 years
3. Have you had any problems with material performance over 25 years (breakage, degrading, etc.)?
   a. No – None at all.
4. Have you had any Contractor issues with materials?
   a. The Contractors have a tendency to complain in the winter time, because the material becomes a little more difficult to work with when cold. For example a 2 inch service line can be a little difficult when temperatures are lower.
5. Why did you guys make the switch to HDPE 25 years ago?
   a. Because it is a pretty thick, durable material, in most cases it is more maintenance free. Our inspectors don’t have to watch it as closely to make sure it is bedded right while being installed. It performs better in corrosive soils.
6. Does the City own the service line or the homeowner?
   a. The City owns the service line from the main to the back side of the meter setter.

Before we ended the call I asked if she could send me a copy of their specification to look at. She said that she would, it is not a real tight spec, but it has worked well for them for 25 years, it is a revision to the Washington State DOT Standard Specifications.

Prepared By: Keith A. Winter
APPENDIX C

PIPE SIZE AND MATERIAL COMPARISONS
FIGURE 1-A

PIPE MATERIAL COMPARISONS - Inside Diameters for given Standard Ductile Iron Sizing

<table>
<thead>
<tr>
<th>Nominal Pipe Diameter (Inches)</th>
<th>CIOD/DIOD Sizing (in.)</th>
<th>INSIDE DIAMETER - INCHES (AWWA Minimum)</th>
<th>3408 Pressure Class</th>
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Note: Average Inside Diameter (ID) is less than that shown in table due to manufacturing tolerances.
### FIGURE 1-B

**PIPE MATERIAL COMPARISONS - Inside Diameters for given Standard Ductile Iron Sizing**

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<th>Nominal Pipe Diameter (Inches)</th>
<th>GID/DIOD Sizing (in.)</th>
<th>Inside Diameter - Inches (AWWA Minimum)</th>
<th>PE 4710 based on ASTM F714 (not yet in AWWA Std)</th>
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Note: Average Inside Diameter (ID) is less than that shown in table due to manufacturing tolerances.
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<td>C900 adopted 1975</td>
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<td><strong>Pressure Class/Rating</strong></td>
<td>Rated to 350 psi</td>
<td>Rated to 315 psi</td>
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<td>for PE 2406 or PE 3406. 51 to 254 psi</td>
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<td>ASTM D 2241</td>
<td>for PE 3408. Rated up to 254 psi for</td>
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<td>&lt;20-inch. ASTM D 3035</td>
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<td>Design for internal pressure, no design</td>
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<td>standard for external loading</td>
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<td><strong>Internal Pressure Design</strong></td>
<td>Designed for working pressure</td>
<td>Designed for working pressure</td>
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<td>plus surge pressure cannot</td>
<td>Hydrostatic Basis (1,600 psi/2.0</td>
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<td>cannot exceed minimum yield</td>
<td>exceed min. yield of 6000</td>
<td>safety factor) Surge pressure</td>
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<td>of 42,000 psi/2.0 safety factor</td>
<td>psi/2.0 safety factor</td>
<td>decreases the safety factor</td>
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<td><strong>External Load Design</strong></td>
<td>Prism load + truck load. Ring</td>
<td>40% of OD between the plates</td>
<td>AWWA M55 Design Standard- Wall</td>
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<td>to 3% of the outside diameter</td>
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<td><strong>Live Load</strong></td>
<td>AASHTO H20, single 16,000 lb</td>
<td>AASHTO H20, single 16,000 lb</td>
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<td>of 1.5 for all depths</td>
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<td><strong>Trench Conditions</strong></td>
<td>Five conditions for depth and soil</td>
<td>Three Options based on soil strength</td>
<td>Requires special considerations. See</td>
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<td></td>
<td>strength and conditions</td>
<td>and depth of burial</td>
<td>AWWA M55 Design Standard</td>
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<td><strong>Hydrostatic Testing</strong></td>
<td>Tested at 500 psi for 10 seconds at full pressure</td>
<td>Quick Burst Test run every 24 hours of production, at 2.0 times pressure rating</td>
<td>Quick Burst test or ring tensile test or a 5 second pressure test, once per production run</td>
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<td><strong>Factory Testing</strong></td>
<td>Minimum yield strength 42,000 psi and ultimate of 60,000 psi and a minimum elongation of 10%. Use of Charpy impact samples</td>
<td>Flattening resistance, 5 second hydrostatic, Acetone, sustained pressure, hourly dimensional tests</td>
<td>Bend-back or elongation-at-break; Ring tensile, or quick burst, 5 second hydrostatic test. Melt flow index, and density</td>
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<td><strong>Tensile Strength (Short Term Values)</strong></td>
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<td>7,000 psi ASTM D638</td>
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<td><strong>(HDB) Hydrostatic Design Basis (Failure after 100,000 hrs)</strong></td>
<td>No measurable relationship between strength and time</td>
<td>HDB 4000 psi - PVC 12454</td>
<td>HDB 1,250 psi – PE 2406 &amp; 3406 1,600 psi – PE 3408</td>
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<td><strong>Pipe Class (Stiffness)</strong></td>
<td>24-inch Class 200: 234 psi 30-inch Class 150: 133 psi 36-inch Class 150: 108 psi</td>
<td>24-inch DR 18: 235 psi 30-inch and 36-inch DR 32.5: 125 psi</td>
<td>24-inch DR 9: 218 psi 30-inch DR 11: 112 psi 36-inch DR 13.5: 57 psi</td>
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<td><strong>Tapping</strong></td>
<td>Direct tap with or without saddle</td>
<td>Direct tap with or without saddle</td>
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### HDPE BOUYANCY

#### PE 4710 - Bouyancy Considerations

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"Full" means with water

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#### DR 13.5 (160 psi) Pipe

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APPENDIX D

INTERNET SEARCH DATA
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<th>Source Web Page Link</th>
<th>Notes/Special Information</th>
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<td>Expert Opinion Article by Camille George Rublee, PE on HOPE Solutions for Infrastructure Rehab</td>
<td>4-May-12</td>
<td><a href="http://greenbuildingsolutions.org/Main-Menu/home/Modern-ASCE">http://greenbuildingsolutions.org/Main-Menu/home/Modern-ASCE</a> mentions this author by name</td>
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<tr>
<td>Expert Opinion Article by Camille George Rublee, PE on HOPE Solutions for Infrastructure Rehab</td>
<td>1-Dec-04</td>
<td><a href="http://www.wwater.org/resources/LiteraturePublicServiceReports/">http://www.wwater.org/resources/LiteraturePublicServiceReports/</a> AWWA Research Foundation paper</td>
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<td>Expert Opinion Article by Camille George Rublee, PE on HOPE Solutions for Infrastructure Rehab</td>
<td>8-Oct-10</td>
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<td>Industry</td>
<td>Pipeline Fittings available for use on HOPE Pipe.</td>
<td>20-Jan-12</td>
<td><a href="http://www.raesa.com/CATALOGS/605h-606.pdf">http://www.raesa.com/CATALOGS/605h-606.pdf</a></td>
<td>Largest Nominal Pipe Size = 12 Inch</td>
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<td><a href="http://www.wwater.org/resources/LiteraturePublicServiceReports/">http://www.wwater.org/resources/LiteraturePublicServiceReports/</a> AWWA Research Foundation paper</td>
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<td><a href="http://www.chartersplastics.com/pdf/possible-p5105-3605-c-tube-butt-Fusion">http://www.chartersplastics.com/pdf/possible-p5105-3605-c-tube-butt-Fusion</a> is recommended method of joints/fitting attachments</td>
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Users
- Kane, County, Utah: p.30 of spec.
- Lawrence, KS: p.4 of spec.
- Big Sky, MT: p.30 of spec.
- Covington, WA: 3-May-12
- Lexington, KY: 4-Apr-12
- Austin, TX: 4-Apr-12
- Guilderland, NY: 4-Apr-11
- Citrus, Florida: 1-Apr-06

For more information, visit the following links:
- http://www.wwater.org/resources/LiteraturePublicServiceReports/
Internet Search - Storm Pipe using HDPE Profile Wall

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<td><a href="http://www.armytec.com/Products/StormDrain/AutoMated-Solution/HDD_Pipe_GC.pdf">http://www.armytec.com/Products/StormDrain/AutoMated-Solution/HDD_Pipe_GC.pdf</a></td>
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<td>Union City, Oregon</td>
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<td><a href="http://www.cityofuc.org/UnionCityStormWastePipeSpecs.html">http://www.cityofuc.org/UnionCityStormWastePipeSpecs.html</a></td>
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<td>CANADA</td>
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<td><a href="http://www.calgary.ca/PQA/DBA/Documents/urban_development/publications/Waterworks2012.pdf">http://www.calgary.ca/PQA/DBA/Documents/urban_development/publications/Waterworks2012.pdf</a></td>
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**Fittings for Repairs- Users Manual**

http://plasticspipe.org/pdf/chapter15.pdf
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Denver Pipe Bursting
Trenchless

GENERAL INFO
http://hdpeoxidation.com/
http://www.differencebetween.net/object/difference-between-hdpe-and-pvc/
http://www.all-about-pipe.com/HDPE-Pipe.html
http://www.trenchlessonline.com/index/webapp-stories-action?id=679

FHWA / AASHTO
NCHRP Report 696  National Cooperative Highway Research Program
Proposed AASHTO Structural Design Properties for Corrugated Polypropylene
http://www.fhwa.dot.gov/construction/cqit/nelvrt.cfm

ASTM / ANSI
http://www.astm.org/Standards/D3350.htm
http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/JAI/PAGES/JAI102910.htm

AWWA / ASCE
http://asciilibrary.org/cgi/abs/ab10.1061/40745%281461%2922
http://www.awwa.org/Resources/content.cfm?ItemNumber=58889
http://cedb.asce.org/cgi/WWWdisplay.cgi?268473
http://www.performancepipe.com/en-us/ww/Pages/AppendixAPressureClassSelectionPerAWWAC906.aspx

INDUSTRY  PPI
http://www.performancepipe.com/en-us/ww/Pages/FAQ.aspx
http://plasticpipe.org/municipal PIPE/sewer_force_main.html
http://www.trenchlessonline.com/index/webapp-stories-action?id=1557
http://undergroundconstructionmagazine.com/water-main-break-study-released
TR-4 Listed Materials 4/30/2012
TR-19/2005 Weatherability of Thermoplastic Piping Systems

PROFILE WALL PIPE - INDUSTRY
http://plasticpipe.org/drainage/cppa_specifications.html
http://plasticpipe.org/drainage/cppa_technical.html
APPENDIX E

PRESSURE CLASS SELECTION
APPENDIX A. PRESSURE CLASS SELECTION PER AWWA C906

Selecting the right pressure class for high density polyethylene pipe (HDPE) in accordance with AWWA C906 can be done in two easy steps. AWWA C906 takes into account the continuous pumping and transient (surge) pressures that occur in municipal water pipes.

**Step 1. Compare the pipeline working pressure with the pipe’s pressure class.**

AWWA C906 defines working pressure as "the maximum anticipated, sustained operating pressure applied to the pipe exclusive of transient pressures." The maximum working pressure for a pipe must be less than or equal to the pipe’s pressure class. Table A-1 gives pressure classes for standard dimension ratio’s (DR) HDPE pipe made from PE3608 material.

| Pipe DR | Pressure Class/Maximum Working Pressure (psig) | Maximum Total Pressure
during Recurring Surge (psig) | Maximum Total Pressure
during Occasional Surge (psig) | Maximum Test Pressure Allowed per AWWA Manual MSS (psig) |
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1 Average annual water temperature above 80°F require derating. See Table 4.
2 Total pressure equals the combined pumping (working) pressure plus surge pressure. Recurring or frequently occurring surges are inherent to the design and operation of the system. Occasional surges are caused by emergency operations such as fire flows.

**Step 2. Compare the peak pipeline pressure during surge with the pipe’s allowable maximum total pressure.**

Peak pressure during a surge is equal to the sum of the pumping pressure and the transient surge pressure. Transient surge pressure depends on the instantaneous change in flow velocity. Maximum transient pressure due to the change is given in Table A-2. Peak pressure may be obtained by adding the surge pressure at the design velocity from Table A-2 to the pumping pressure. Peak pressure is compared with the maximum total pressure allowed during surge found in Table A-1. The maximum total pressure allowed equals 1.5 times the pipe's pressure class for recurring surge and 2.0 times the pipe's pressure class for occasional surge.

**Note:** The surge pressure occurring in HDPE pipe is significantly lower than surge pressures occurring in cast or ductile iron pipe and is lower than that in PVC pipe of the same DR. For example, a 4 fps instantaneous velocity change in HDPE DR17 pipe results in a 45.0 psi surge whereas for DI pipe the surge is 290 psi and for PVC DR18 pipe the surge is 69.6 psi. When HDPE pipe is connected to DI pipe the surge pressure is dampened by the HDPE pipe.

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**Working Pressure and Surge Pressure Example:**

An engineer is designing a water system that operates at 85 psig and has some runs in it where the flow velocity is 4 fps. In addition, his/her state requires a 150 psig test for the pipeline. What DR pipe does the engineer use?

**Step 1.** Compare the pumping pressure (85 psig) with the available pressure classes in Table A-1. DR17 has a PC of 100 psig > 85 psig. The test pressure of DR17 is also 150 psig, which meets the specified test pressure.

**Step 2.** The anticipated peak pressure in the pipeline is found by adding the pumping pressure of 85 psig to the surge pressure of 45.0 psig (given in Table A-2 for a 4 fps velocity). The surge equals 130.2 psig is less than the maximum total pressure allowed for recurring surge for DR17 pipe of 150 psig. DR17 pipe is okay. A similar comparison can be made for peak pressure during fire flow where velocity may reach 8 fps. In this case add 300.0 psig (from Table A-2) to 85 psig to obtain a peak pressure during occasional surge of 175 psig. Compare with the maximum total pressure allowed for occasional surge for DR17 of 200 psig. DR17 pipe is okay.
APPENDIX F

AWWA STANDARD C906
REVISION NOTICE
Standards notice

ANSI/AWWA C906-12, AWWA Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,600 mm), for Waterworks

The AWWA Standards Council has approved revisions to this standard for public comment. The publication of this information on the AWWA website begins the 30-day comment period for action on standards by the Standards Council. Copies of the revised standard are available during the comment period for $20 each from AWWA.

Update: AWWA Comment Period is now closed - review copies are no longer available

The final draft you receive for review will be edited for publication and may also be revised as appropriate based on any comments received during the public comment period. Please note: The public comment period closes on June 1, 2012. Therefore, this copy is not suitable for continued utilization and is intended only for comment purposes. If you have any comments, please contact Ken Mercer at 303-347-6191 or kmercer@awwa.org, or send a fax to 303-795-7603.

Update: AWWA Comment Period closed on June 1, 2012.

The final published copy of the standard will not be available for some time. When it is available, a notice will be placed in the official notice section of Journal - American Water Works Association. The standard then becomes an effective AWWA standard on the first day of the month following such publication in Journal - AWWA. You may wish to watch for this notice in Journal - AWWA and order your published copy at that time.

(Revision of AWWA C906-07)

Scope

This standard describes polyethylene (PE) pressure pipe and fittings made from materials conforming to standard PE materials designation codes PE 2606, PE 2706, PE 2708, PE 3608, PE 3708, PE 3710, PE 4608, PE 4708 and PE 4710.* The pipe and fittings are primarily intended for use in transporting potable water, wastewater and reclaimed water in either buried or aboveground installations. The standard describes 12 dimension ratios (DRs) for nominal pipe and fitting sizes ranging from 4 in. through 65 in. (100 mm through 1,600 mm). Pipe and fitting outside diameters (ODs) conform to the outside diameter dimensions of iron pipe (IPS), or to equivalent ODs for DI pipe (DIOD).
Major Revisions

1. Sec. 1.1 Scope. Removed material designations made obsolete by changes to ASTM D3350 and replaced with current and new material designations.

2. Section 2 References. Added five ASTM standard references, reference to ANSI/AWWA standard, and reference to PPI TR-4. Deleted references to seven ANSI/AWWA standards and one ASTM standard and one AWWA report.

3. Section 3 Definitions. Revised definitions for design factor, dimension ratio, hydrostatic design basis, hydrostatic design stress, and pressure class. Added definitions for cracking, crazing, brittle failure, ductile failure, rework plastic, and virgin plastic.

4. Section 4 Requirements.
   a. Sec. 4.2, revised material requirements to be consistent with new material designations. Revised Table 1 and removed Table 2.
   b. Sec. 4.3 Revised workmanship; added custom sizes; revised tolerances; revised toe-in; revised elevated temperature sustained pressure test; revised Tables 2, 3, 4, 5, 6, 7; revised quick-burst test, bend-back test, elongation-at-break test, five-sec pressure test, UV stabilization, melt, density, ring-tensile test.
   c. Sec. 4.4. Added materials; revised workmanship, dimensions and tolerances, physical requirements. Removed backup rings footnote.
   d. Deleted Sec. 4.5 and Sec. 4.6

5. Sec. 5.1 through Sec. 5.8 revised.

6. Section 6, Delivery revised
   a. Sec. 6.1 revised and added Table 5;
   b. Sec. 6.3 revised.


8. Revision to include PE 2708, PE 3710, and PE 4710 compounds. This standard is revised to include polymers that have demonstrated satisfactory service internationally under the designation PE 100. Domestically, the ASTM designations PE 2708, PE 3710, and PE 4710 are used. These materials have been subjected to testing that meets or exceeds the requirements of PE 100 materials; the materials are sometimes referred to as PE 100+ materials. These materials have not been included in previous versions of ANSI/AWWA C906, which only addressed PE 2406, PE 3406, and PE 3408.

PE 2708, PE 3710, and PE 4710 can perform at higher long-term stresses than previous compounds because they are more resistant to slow crack growth formation that leads to stress-related plastic pipe failure. This is achieved without a significant increase of yield strength. Increasing the strength of plastic is generally accompanied by loss of ductility, an important property for surge pressure resistance, fatigue,
flexibility, and toughness. All PE compounds in this standard include an allowance for occasional surge of 100 percent of pressure class (PC) and 50 percent of pressure class for recurring surge. The minimum 5-second pressure rating (burst strength) by ASTM D1598 of all PE pipe and fittings covered by this standard is at least 3 times pressure class.

Three additional criteria are used to establish that materials will perform acceptably at higher operating pressures:

- Ductility - the material must remain ductile under sustained stress through the 50-year intercept;
- Slow crack growth resistance - the minimum failure time under ASTM test method F1473 (PENT) has been increased from 100 hrs to 500 hrs; and
- Performance reliability - the lower confidence limit of the projected average value of the material's long-term hydrostatic strength by ASTM D2837 has been increased from 85 percent to 90 percent.

The material designations PE 2708, PE 3710, and PE 4710 are the only materials covered by this standard that meet these requirements. This standard applies a 0.63 design factor to the Hydrostatic Design Basis to determine Hydrostatic Design Stress for PE 2708, PE3710, and PE4710 materials. This is consistent with global and domestic industry standards ANSI/AWWA C901, ASTM F714, ASTM D3035, ASTM D3350, and CSA B137.1, and gas standards ASTM D2513, ASTM F2619, API 15LE, CSA 137.4 and CSA Z662 (Clause 12 and 13.) The design factor for the other material designations listed in the standard remains 0.5.

Determination of reliable maximum sustained long-term hydrostatic strength ratings for thermoplastic pipe considers many factors. As the use of plastic pipe emerged in the mid-20th century, the need was recognized for a single authoritative resource, using consistent and appropriate methodologies, to determine strength ratings for thermoplastic pipe. Since 1961, recommendations for maximum long-term hydrostatic strength ratings of plastic pipe materials (e.g. PVC, CPVC, PE, PEX and others) have been determined and issued by the Hydrostatic Stress Board (HSB) of the Plastics Pipe Institute. In keeping with other AWWA standards, maximum hydrostatic design strength ratings in this standard are consistent with the recommendations of the Hydrostatic Stress Board. Interested readers may obtain more information about Hydrostatic Stress Board policies and procedures through the Plastics Pipe Institute, Irving, Texas.

* Note 1 – Earlier editions of ANSI/AWWA C906 included PE material designations PE 2406, PE 3406 and PE 3408. Changes to ASTM D3350 and PPI TR-3 led to changes in thermoplastic materials designation codes, resulting in material designation PE 2406 being superseded by material designations PE 2606, PE 2706, and PE 2708, material designation PE 3406 being discontinued, and material designation PE 3408 being superseded by material designations PE 3608, PE 3708, PE...
3710, PE 4608, PE 4708 and PE 4710, with the most common
designations being PE 2708, PE 3608 and PE 4710. Accordingly,
material designations and descriptions for the superseded PE 2406, PE
3406 and PE 3408 designations have been removed from ANSI/AWWA
C906. For removed designations, refer to previous editions of
ANSI/AWWA C906, ASTM D3350, PPI TR-3 and PPI TR-4. The removal
of superseded material designations does not affect pipelines that are
in service. Recognizing that a transitional period is necessary for the
dissemination of information and to update specifications and industry.

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